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REVIEW ARTICLE

Prevalence of acute kidney injury after hematopoietic stem cell transplantation in pediatric populations: a systematic review and meta-analysis

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Abstract: **Background:** The prevalence of acute kidney injury (AKI) associated with hematopoietic stem cell transplantation (HSCT) is well-established in the adult population. Similarly, AKI following HSCT is frequently encountered in the pediatric population. However, adequate information regarding the prevalence among children and adolescents is lacking. We conduct a systematic review to investigate the current literature specifically addressing the prevalence of AKI in children treated with HSCT. **Methods:** An extensive search was performed using Medline, Embase, Scopus, and Web of Science databases until May 5, 2025. We systematically reviewed and included all clinical trials and observational studies. Two independent researchers screened the studies, recorded the required data, and assessed the risk of bias. The studied outcomes included the prevalence of AKI and the need for renal replacement therapy (RRT). The data included were analyzed in the STATA 18.0 statistical program. **Results:** Forty-nine articles were eligible for inclusion. The prevalence of pediatric AKI after HSCT was 34.18% (95% confidence interval (CI): 28.08 to 40.53; I2=97.79%). The need for RRT following HSCT was equal to 3.54% (95% CI: 1.98 to 5.45; I2= 95.10%). The origin of hematopoietic stem cells and AKI determination cutoff points were found to be the most predictive of AKI prevalence. The prevalence of AKI after transplantation of hematopoietic cells derived from umbilical cord blood was significantly higher than other cell sources (69.55%; 95% CI: 22.23, 100.0). **Conclusion:** The prevalence of pediatric AKI and RRT after hematopoietic cell transplantation is significant, and is 34.18% and 3.54%, respectively. The highest prevalence of AKI among the different sources of hematopoietic stem cells was observed in cord blood transplantation. However, the available evidence on the prevalence of AKI following the transplantation of hematopoietic stem cells derived from cord blood is insufficient, and more research is needed in this field. As a suggestion, it is recommended to use sources other than hematopoietic cells derived from umbilical cord blood until sufficient evidence is available.

Keywords: Acute kidney injury; Hematopoietic stem cell transplantation; Renal replacement therapy; Child

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1. Introduction

Cell-based therapy is considered one of the most promising disciplines in the field of modern science and medicine and it holds a promising potential for the treatment of chronic diseases (1). The therapeutic potential of cell-based therapy has proven successful in several clinical trials conducted in children. For example, HSCT has been shown to be effective as a curative treatment for a wide range of neurological, hematology, and metabolic diseases and even cancer (2, 3). However, the side effects are still not fully understood since cell-based therapies are still at an early stage of development.

Acute kidney injury (AKI) is an adverse event after cell-based therapy. AKI occurs commonly after hematopoietic cell transplantation affecting approximately 10% to 73% of patients. Importantly, AKI after HSCT is associated with substantial morbidity, including the development of chronic kidney disease, end-stage renal disease, and the need for dialysis. The kidney injury directly associated with HSCT includes a wide range of functional and structural abnormalities and the cause is often multifactorial. In a retrospective study on

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children treated with HSCT, the prevalence of acute kidney injury, stage 3 acute kidney injury, and acute kidney injury requiring dialysis or transplant replacement therapy were 2.68%, 25% and 6.7%, respectively. The study also demonstrated a high one-year mortality rate among HSCT patients with stage 3 AKI compared to those without AKI (4). Subsequent studies have demonstrated very high rates of AKI up to 84% after cell-based therapy (5).

Although there is detailed information about the prevalence of AKI following cell transplantation in adults, there is no consensus regarding its prevalence in children and adolescents. To highlight emerging evidence that HSCT may contribute to the development of AKI, we intend to conduct a systematic review to investigate the overall prevalence of AKI in children treated with hematopoietic cells.

2. Methods

2.1. Study design

The present study is a systematic review of clinical trials and observational studies conducted with the aim of investigating the prevalence of acute kidney injury in children and adolescents treated with hematopoietic cells. The definition of PICO in this study included P: children treated with hematopoietic cells, I: hematopoietic cell transplantation, C: comparison with the group without acute renal injury, and O: acute renal injury and the need for renal replacement therapy (RRT).

2.2. Search strategy

To get the answer to the question of the present study, Medline, Embase, Scopus, and Web of Science databases were searched. Key words related to acute kidney injury and key words related to hematopoietic cell therapy were selected and then searched in each database with the appropriate combination. The search was conducted until May 5, 2025. In addition to the systematic search, a manual search was also performed in gray literature. The search strategy is presented in Appendix 1. To find pediatric articles, standard pediatric filters were used in each database.

2.3. Selection criteria

Cohort studies and clinical trials conducted on the prevalence of acute kidney injury in children treated with hematopoietic cells were included in the present study. Exclusion criteria included failure to report acute renal injury and RRT as an outcome, case reports, review studies, repeated studies, and retracted studies. Studies with more than 90% of participants under 18 years old were also included and considered as pediatric populations.

2.4. Data extraction

The search was carried out in each database and in the next step, the titles and abstracts of the articles were studied by two independent researchers after removing the duplicates. Any studies that met the inclusion and exclusion criteria were selected for full text review. Then relevant articles were selected and summarized by two independent researchers. The summary included data related to the article's library information (name of the first author, year of publication, location of the study), type of study, age and sex distribution of the children, sample size, reason for treatment with hematopoietic cells, source of hematopoietic cells, follow-up period, the criteria for defining acute kidney injury, and prevalence of acute kidney injury and RRT.

2.5. Risk of bias assessment

Quality status of the articles was assessed using the NIH guidelines of cohort studies. This tool is a 14-question checklist based on which the quality of articles is assessed in terms of methodology, report of findings, and possible distortions. The risk of bias assessment was conducted by two independent researchers who evaluated each question with "yes" (low risk), "no" (high risk), "cannot be determined" (CD), "not reported" (NR), and "not applicable" (NA). The overall risk of bias was determined based on fatal errors, including participation rate if less than 50% (item 3), priority outcome assessment to exposure measurement (Item 6), inadequate time frame between exposure to outcome assessment (item 7), bias in outcome assessment (item 11), and loss to follow-up more than 20% (item 13). Studies that received a "no," CD, or NR in at least one of the fatal error items were considered to have poor quality.

2.6. Statistical analysis

The prevalence of acute kidney injury and RRT in children treated with hematopoietic cells was investigated with the use of "meta" package in the Stata statistical software 18.0. The output of this command was reported as pooled prevalence with a 95% confidence interval (CI). Since it was expected that there would be considerable methodological and clinical heterogeneity between included studies, it was decided to use a random-effect model from the beginning. In addition, subgroup analysis and meta-regression were performed based on the source of hematopoietic cells, the criteria for defining AKI, and the duration of follow-up. Additionally, sensitivity analysis was performed to assess the effect of including younger adults (including studies up to 10% of participants over 18 years) and studies with an extreme prevalence of AKI (more than 70%) and RRT (more than 25%). These cut-offs for extreme prevalence were adopted based on the Galbraith plot prior to the primary analyses. Finally, Egger's test and funnel plot were used to identify publication bias (6).

3. Results

3.1. Characteristics of included studies

The initial search resulted in 10111 articles. After eliminating 2499 duplicates, a total of 7612 articles were screened by re-

viewing the titles and abstracts. 218 full texts were retrieved, and finally, 49 articles were included in the present meta-analysis (48 papers in systematic search and one paper in the manual search) (4, 5, 7-53). 170 studies were excluded: 82 cases due to lack of reporting the desired outcome, 15 cases due to being case reports, 20 cases due to being review studies, 44 cases due to lack of examination of children, 6 cases due to duplication, 3 cases due to lack of separation, and 1 case due to evaluation of one nephrotoxic factor. The findings from adults were excluded. Figure 1 shows the selection process of the studies included in this article.

From the included articles, 7 studies were prospective and 42 were retrospective. Collectively, these studies evaluated a total of 26231 patients in the age range of 0 to 22.9 years, of which 59.39% were boys. The reason for need of hematopoietic stem cell transplantation was reported in two general groups: malignant and non-malignant. Most of the studies considered the serum creatinine level as a criterion for diagnosing acute kidney injury. Among these studies, 20 studies showed a serum creatinine level more than 1.5 times the baseline state, 5 studies showed a serum creatinine level more than 2 times the baseline state. In 25 studies, the source used in hematopoietic stem cell transplantation was bone marrow, umbilical cord, and peripheral blood. The follow-up period of the studied patients ranged from 28 days to 3650 days, and most of the studies followed the patients between 90 and 100 days. In the examination of renal outcome, 21 studies reported only acute kidney injury, 3 reported only RRT, and the rest reported both. The characteristics of the included studies are detailed in Table 1.

3.2. Prevalence of AKI and RRT after hematopoietic stem cell transplantation

In the analysis, the prevalence of acute kidney injury after hematopoietic stem cell transplantation was 34.18% (95% CI: 28.08 to 40.53; I2=97.79%) (Figure 2). Also, the need for RRT following renal failure after hematopoietic stem cell transplantation was equal to 3.54% (95% CI: 1.98 to 5.45; I2= 95.10%) (Figure 3).

As can be seen, there is significant heterogeneity between studies. Subgroup analysis was performed according to the source of hematopoietic stem cells and the cut-off point for determining AKI to find the cause of the heterogeneity of the data (Table 2). In the analysis performed, the source of hematopoietic stem cells and the cut-off point for determining AKI were identified as the causes of data heterogeneity in the prevalence of AKI. The prevalence of AKI in children who used the umbilical cord source was 69.55% (95% CI: 22.23, 100.0, I2=96.83%). The prevalence of AKI following hematopoietic cell transplantation with bone marrow origin was 40.19% (95% CI: 23.13, 58.50, I2=94.02%), for peripheral blood source this rate was 37.58% (95% CI: 19.97, 56.84, I2=81.10%), and for Bone marrow/peripheral blood it was 28.17% (95% CI: 16.78, 41.11, I2=91.75%); also, from all three sources (bone marrow, umbilical cord, and peripheral blood) the rate was 40.46% (95% CI: 32.21, 48.97, I2=96.87%). The meta-regression test showed that the prevalence of AKI after transplantation of hematopoietic cells derived from umbilical cord blood was significantly higher than other cell sources. Also, the prevalence of AKI following hematopoietic cell transplants is influenced by the cutoff point of AKI definition. As Table 2 shows, although the prevalence of AKI in studies that included stage 1 patients in the AKI group (42.84%) was higher than studies that used stage 2 (30.83%) as the definition of AKI, this difference was not statistically significant (p=0.116). It was also found that the reported prevalence of AKI in studies was not affected by the duration of follow-up of patients (p=0.291) (Figure 4).

In investigating the source of heterogeneity between the studies that assessed the need for dialysis as an outcome, the source of hematopoietic stem cells and the cutoff point for determining AKI were not the causes of heterogeneity. Finally, meta-regression demonstrated that the prevalence of AKI (p=0.309) and the need for RRT (p=0.291) were not affected by the duration of follow-up of patients (Figure 4).

3.3. Sensitivity analysis

To evaluate the impact of potential outliers, we conducted a sensitivity analysis by removing data from two studies that reported an AKI prevalence above 70%, identified using a Galbraith plot. The results showed that the pooled prevalence changed from 34.18 to 31.13 (95% CI: 25.72 to 36.79), indicating that this adjustment did not significantly affect our findings.

Additionally, another sensitivity analysis was performed to assess potential outliers in the prevalence of RRT, also identified using a Galbraith plot. After removing one study with a prevalence above 25%, the pooled prevalence changed slightly from 3.54% to 3.18% (95% CI: 1.81 to 4.83), without noticeable impact on the overall findings (Figures 6 and 7).

Another sensitivity analysis was conducted to evaluate the impact of studies that included some participants over 18 years old (including individuals up to 22.9 years). The analysis showed that the prevalence of AKI changed from 34.18% to 34.90% (95% CI: 28.66 to 41.39), indicating no clinically important difference. Moreover, a similar analysis was conducted for RRT prevalence, with the pooled prevalence slightly changing from 3.54% to 3.53% (95% CI: 1.72 to 5.82), demonstrating that including younger adults did not significantly change the prevalence of RRT.

3.4. Publication bias and risk of bias assessment

Egger's test demonstrated that there was no publication bias in assessment of AKI prevalence (p=0.201) and the need for RRT (p=0.424) (Figure 5). In risk of bias assessment Items 4, 8, 9, 10, 12, and 14 were marked as "not applicable" as the study focused on prevalence. The overall risk of bias was considered low in 27 studies due to no adequate reports of participation rate, while the other studies were rated as fair.

4. Discussion

In the present meta-analysis, we report the prevalence of AKI and the need for RRT in children after HSCT for the first time. Our detailed analysis revealed that the prevalence of AKI and RRT after HSCT is significant and is 34.18% and 3.54%, respectively. Subgroup analysis demonstrated that HSCT from umbilical cord blood resulted in the highest prevalence of AKI, with a significant percentage of 69.55%. Another possible reason for the heterogeneity of the articles was the use of different cut-off points for determining AKI. We found that stage 1 AKI had the highest prevalence.

Compared to the findings of other similar meta-analyses, Kanduri and his colleagues demonstrated that the prevalence of acute kidney injury and the need for RRT following HSCT was 55.1% and 7.2%, respectively (54). Although there is a significant difference between the prevalence of AKI and RRT between adults and children, the prevalence of AKI after HSCT is high in both populations. As a result, more considerations should be given to this subject to obtain a better understanding of AKI among pediatric patients receiving HSCT.

It is suggested that the patients receiving HSCT should have their renal function monitored closely within the first hour to detect early stages of AKI and prevent the need for RRT. A systematic review of 4 pediatric studies by Didsbury et al., showed that the prevalence of AKI following HSCT was 21.7% (55), which is lower than the prevalence of AKI found in the present study. The reason for this difference can be the larger number of studies included in our analysis.

A pitfall in identifying acute kidney injury is that it takes time to diagnose. In the diagnostic guidelines of AKI, an increase in serum creatinine during the first 48 to 72 hours is used as a marker to identify kidney injury. Delays in diagnosis contributes to late treatment and higher mortality. To circumstantiate these consequences, some researchers suggest the use of other biomarkers such as NGAL, cystatin C, interleukins, etc. in the early diagnosis of renal failure (56, 57). As the number of cases of long-term consequences due to AKI increases, the need for early diagnosis becomes paramount. Therefore, we suggest that future studies focus on applying new diagnostic criteria for AKI to facilitate early identification of kidney injury.

According to the present meta-analysis, the prevalence of AKI following hematopoietic stem cells harvested from umbilical cord blood is significantly higher than other cell sources. However, there are insufficient studies about the prevalence of AKI following HSCT derived from umbilical cord blood. Therefore, further studies are necessary to conclude on the prevalence of AKI in association with HSCT. In the meantime, we suggest using sources other than umbilical cord blood for HSCT until new evidence and data are available.

In the current study, 3.54% of children undergoing hematopoietic cell transplantation required renal replacement therapy such as dialysis. While the prevalence reported in this paper may not be high, it should be noted that if a pediatric patient does develop renal failure after HSCT, they are likely to require long term dialysis until renal transplantation. Although kidney transplant is shown to be safe and successful in the pediatric population, some of the long-term side effects are more severe compared to adults. Renal failure affects the overall quality of life of children and their families, which often requires comprehensive treatment for psychosocial problems.

5. Limitations

One of the limitations of the present study is not being able to find the cause of heterogeneity in the prevalence of the need for RRT. In the present study, an attempt was made to find the cause of heterogeneity. The origin of hematopoietic stem cells and AKI determination cut-off points were not the cause of heterogeneity. It should also be noted that further subgroup analysis was not possible due to the lack of sufficient information. Another limitation of the current study was the small sample size in some of the included articles. This small sample size is due to stem cell-based therapy not being as common as other treatment modalities in the clinical settings. However, to have a better understanding of this subject, it was necessary to collect any existing data. Another limitation of the present study was the difference between the follow-up period of the patients. To solve this problem, a quantitative meta-regression was performed, and it was found that the difference in the duration of follow-up has no effect on the prevalence of AKI and the need for reported RRT in the studies.

One of the limitations of this meta-analysis is the inclusion of studies in which a small number of patients were older than 18 years (up to 22.9 years old). However, this limitation is negligible as sensitivity analyses showed that the prevalence of AKI and RRT did not change significantly when these studies were excluded.

6. Conclusions

For the first time, the prevalence of acute kidney failure and the need for RRT in the pediatric population after HSCT is reported in this meta-analysis. Our findings indicate that the prevalence of AKI and RRT after HSCT is significant and is 34.18% and 3.54%, respectively. Subgroup analysis demonstrated that the highest prevalence of AKI among different sources of hematopoietic stem cells was in umbilical cord blood transplantation with a significant percentage of 69.55%. However, the available evidence on the prevalence of AKI after the transplantation of hematopoietic stem cells derived from umbilical cord blood is insufficient and further research on this subject area is needed. As a suggestion, it is recommended to use sources other than hematopoietic cells derived from umbilical cord blood until there is sufficient data for a comprehensive conclusion.

7. Declarations

7.1. Acknowledgments

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7.2. Author contributions

Study design: MY, MH, NA; Data gathering: All authors; Analysis: MY and MH; Drafting: MY; Revising: All authors.

7.3. Conflict of Interest

All authors declared that there is no conflict of interest.

7.4. Funding

The study was funded and supported by Tehran University of Medical Sciences (TUMS); Grant no: 98-3-231-46207.

7.5. Ethical statement

The study was approved by ethics committee of Tehran University of Medical Sciences (TUMS).

7.6. Informed consent

Not applicable.

7.7. Availability of data

All data used in the current study were presented in the tables and figures.

7.8. Using artificial intelligence and chatbots

We only used ChatGPT 4.0 to enhance the English writing of the text by checking for spelling and grammar errors.

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Table 1: Characteristics of included studies

Author, year, country	Study type	Sample size	Boys (n)	Age*	Indication for HCT	AKI definition	Source of HCT	Follow up (days)	Outcome
AlAbdullah H, 2024, Saudi Arabia (7)	RCS	173	91	0-14	Malignancy and non-malignancy	NR	BM/UCB /PB	100	AKI/RRT
Ashruf OS, 2024, US (8)	RCS	5168	2980	<18	Malignancy and non-malignancy	↑ Serum Cr > 1.5 times or Cr ≥ 0.3 mg/dL	NR	30	AKI
Avci B, 2024, Turkey (9)	RCS	278	155	0-18	Malignancy and non-malignancy	↑ Serum Cr > 1.5 times or Cr ≥ 0.3 mg/dL	NR	100	AKI/RRT
Barnoud D, 2018, France (10)	RCS	35	25	11 ± 4	Malignancy	↓ eCCl of 20%	BM/UCB/PB	28	AKI/RRT
Bauer A, 2023, US (11)	RCS	484	276	<21	Malignancy and non-malignancy	↑ Serum Cr > 1.5 times or Cr ≥ 0.3 mg/dL	BM/UCB/PB	40	AKI/RRT
Benoit SW, 2019, US (12)	PCS	80	55	4.5-14.3	Malignancy and non-malignancy	↑ Serum Cr > 1.5 times or Cr ≥ 0.3 mg/dL	BM/UCB/PB	28	AKI/RRT
Bratton SL, 2008, US (13)	RCS	5699	3378	1.9-11.8	NR	NA**	UCB	NR	RRT
Chen Z, 2025, China (14)	RCS	357	216	3.6–10.1	Malignancy and non-malignancy	↑ Serum Cr > 1.5 times or Cr ≥ 0.3 mg/dL	NR	100	AKI
Cordero C, 2017, France (15)	RCS	21	19	3-18	Malignancy	↑ Serum Cr > 1.5 times	BM	30	AKI/RRT
da Cunha MM, 2022, Brazil (16)	RCS	43	NR	11-18	Hematologic disease	↑ Serum Cr > 1.5 times or Cr ≥ 0.3 mg/dL	BM/PB	100	AKI/RRT
Daraskevicius J, 2020, Lithuania (17)	RCS	51	35	0.25-17	Malignancy	↓ eGFR of 50%	BM/UCB/PB	98	AKI/RRT
Elborai Y, 2020, US (18)	RCS	20	9	1-13	Malignancy	↑ Serum Cr > 1.5 times or Cr ≥ 0.3 mg/dL	PB	NR	AKI/RRT
Erez DL, 2020, US (19)	PCS	176	105	6-16	Malignancy and non-malignancy	↑ Serum Cr >1.5 times	BM/UCB/PB	120	AKI
Farzin A, 2007, US (20)	RCS	35	NR	2.7-22.9	Fanconi anemia	Not reported	BM/UCB	3650	AKI/RRT
Gadashova A, 2023, Turkey (21)	RCS	94	58	2-18	Malignancy and non-malignancy	↓ eGFR of 25%	BM/PB	1875	AKI/RRT
Gan ZP, 2022, China (22)	RCS	21	NR	<20	Hematologic disease	↑ Serum Cr > 1.5 times or Cr ≥ 0.3 mg/dL	BM/PB	100	AKI
Gurbanov A, 2023, Turkey (23)	RCS	165	108	7.8 ± 5.3	Malignancy and non-malignancy	↑ Serum Cr > 1.5 times or Cr ≥ 0.3 mg/dL	NR	180	AKI/RRT
Hassan NE, 2013, US (24)	RCS	124	54	2.3-17.5	Malignancy	Not reported	BM/UCB/PB	180	AKI
Hazar V, 2009, Turkey (25)	PCS	34	21	2–16.2	Malignancy and non-malignancy	↑ Serum Cr > 2 times	BM/UCB/PB	100	AKI/RRT
Hingorani SR, 2015, US (26)	PCS	14	NR	2-20	Malignancy and non-malignancy	↑ Serum Cr > 2 times	BM/UCB/PB	100	AKI
Hirano D, 2020, Japan (27)	RCS	43	28	4.1–10.8	Malignancy	↓ eCCl of 25%	BM/UCB/PB	100	AKI/RRT
Ileri T, 2010, Turkey (28)	PCS	57	33	1.9–17	Malignancy and non-malignancy	↑ Serum Cr > 1.5 times	BM/UCB/PB	100	AKI/RRT
Kahn J, 2024, US (29)	RCS	5790	3505	<21	Non- malignancy	NA	BM/UCB/PB	2299	RRT
Kist-van Holthe JE, 2005, Netherlands (30)***	RCS, PCS	121, 41	73, 28	0.04–19.3, 0.6–16.9	Malignancy and non-malignancy	↑ Serum Cr > 2 times	BM	90	AKI/RRT
Kizilbash SJ, 2016, US (5)	RCS	205	125	0.3-21	Malignancy and non-malignancy	↓ eCCl of 25%	BM/UCB/PB	100	AKI/RRT
Koh KN, 2018, US (4)	RCS	780	NR	0-15	Malignancy and non-malignancy	↑ Serum Cr > 1.5 times	BM/UCB/PB	100	AKI/RRT
Kurokawa M, 2020, Japan (31)	RCS	69	44	2.1-17	Malignancy and non-malignancy	↑ Serum Cr > 2 times	BM/UCB/PB	100	AKI

Table 1: Characteristics of included studies

Author, year, country	Study type	Sample size	Boys (n)	Age*	Indication for HCT	AKI definition	Source of HCT	Follow up (days)	Outcome
Latifi A, 2024, Iran (32)	RCS	84	NR	<16	Malignancy and non-malignancy	↑ Serum Cr > 1.5 times or Cr ≥ 0.3 mg/dL	BM/UCB /PB	100	AKI
Lee SH, 2011, South Korea (33)	RCS	6	2	0.5-7.25	Malignancy	Not reported	PB	30	AKI
Leimi L, 2022, Finland (34)	RCS	122	76	0.5-17.2	Malignancy and non-malignancy	↑ Serum Cr > 1.5 times or Cr ≥ 0.3 mg/dL	BM/UCB/PB	100	AKI
Matbouly S, 2024, Egypt (35)	RCS	29	16	6.21±3.18	Malignancy and non-malignancy	↓ eCCl of 25%	NR	90	AKI
Matsuoka D, 2021, Japan (36)	RCS	107	65	0-15	Malignancy and non-malignancy	↑ Serum Cr > 1.5 times	BM/UCB/PB	100	AKI/RRT
Michael M, 2004, US (37)	RCS	272	NR	13±5	Malignancy and non-malignancy	↑ Serum Cr > 2 times	BM/PB	90	AKI/RRT
Mori J, 2012, Japan (38)	RCS	10	NR	10–19	Malignancy	↑ Serum Cr > 1.5 times or Cr ≥ 0.3 mg/dL	BM/UCB/PB	100	AKI
Musiał K, 2021, Poland (39)	RCS	135	78	8.27 ± 5.14	Malignancy and non-malignancy	↓ eGFR of 25%	BM/PB	180	AKI/RRT
Musiał K, 2024, Poland (40)	RCS	135	78	8.27 ± 5.14	Malignancy and non-malignancy	↑ Serum Cr > 1.5 times or Cr ≥ 0.3 mg/dL	Mostly	PB 180	AKI
Öztürk M, 2023, Turkey (41)	RCS	47	NR	0.3-18	Malignancy and non-malignancy	NR	NR	NR	AKI/RRT
Prince RD, 2023, US (42)	RCS	791	NR	0-18	Malignancy and non-malignancy	NR	NR	28	AKI/RRT
Rattanaseksan K, 2025, Thailand (43)	RCS	246	135	<20	Malignancy and non-malignancy	NR	NR	100	AKI
Sakaguchi M, 2019, Japan (44)	RCS	9	NR	10–19	Malignancy	↑ Serum Cr > 1.5 times	BM/UCB/PB	100	AKI
Sallam DE, 2024, Egypt (45)	PCS	23	11	14.35 ±5.27	Malignancy and non-malignancy	↓ eCCl of 25%	NR	360	AKI
Sarkar N, 2024, US (46)	RCS	63	44	>2	Malignancy and non-malignancy	↑ Serum Cr > 2 times	BM/UCB /PB	360	AKI/RRT
Satwani P, 2011, US (47)	RCS	170	106	9.5 ± 6.55	Malignancy and non-malignancy	↓ eCCl of 50%	BM/UCB/PB	30	AKI/RRT
Shi W, 2025, China (48)	RCS	79	44	6.75 ± 4.25	Malignancy and non-malignancy	↑ Serum Cr > 1.5 times or Cr ≥ 0.3 mg/dL	BM/UCB /PB	31.62 ± 17.26	AKI
Takahashi T, 2019, US (49)	RCS	2504	1530	0-19	Malignancy and non-malignancy	Not reported	BM/UCB/PB	NR	AKI
Wei A, 2024, China (50)	RCS	149	99	0.57-15.49	Malignancy and non-malignancy	NR	BM/PB	168	AKI
Yu ZP, 2010, China (51)	RCS	36	NR	8-20	Malignancy	↓ eGFR of 25%	BM/UCB/PB	100	AKI
Zinter MS, 2024, US (52)	RCS	1067	624	0-21	Malignancy and non-malignancy	NR	NR	1825	RRT
Zirngibl F, 2025, Germany (53)	RCS	131	79	0.2-19.6	Malignancy and non-malignancy	↓ eCCl of 25%	Mostly PB	180	AKI

*, Age was reported as range or mean ± standard deviation.

**, Not applicable (NA) since the study reported only need for dialysis.

***, Kist-van Holthe JE, 2005 study included two separate databases.

AKI: Acute kidney injury; BM: Bone marrow; Cr: Serum creatinine; eCCl: estimated creatinine clearance; eGFR: Estimated glomerular filtration rate; HCT: Hematopoietic cell transplantation; NR: Not reported; PB: Peripheral blood; PCS: Prospective cohort study; RCS: Retrospective cohort study; RRT: Renal replacement therapy (dialysis); UCB: Umbilical cord blood.

Table 2: Subgroup analysis for prevalence of AKI and RRT following hematopoietic stem cell transplantation

Subgroups	N of analyses	Prevalence (95% CI)	Heterogeneity (p-value)	Meta-regression	P
Prevalence of AKI					
Source of HCT					
UCB	4	69.55 (22.23, 100.0)	96.83% (<0.0001)	Reference	
BM/PB	7	28.17 (16.78, 41.11)	91.75% (<0.0001)	0.24 (0.10, 0.54)	0.001
BM/UCB	1	11.43 (2.61, 24.45)	NA	0.17 (0.05, 0.53)	0.002
PB	6	37.58 (19.97, 56.84)	81.10% (<0.0001)	0.32 (0.14, 0.73)	0.007
BM/UCB/PB	26	40.46 (32.21, 48.97)	96.87% (<0.0001)	0.33 (0.16, 0.67)	0.002
BM	9	40.19 (23.13, 58.50)	94.02% (<0.0001)	0.33 (0.15, 0.71)	0.005
AKI definition's cut off					
Risk/stage 1	33	42.84 (35.88, 49.95)	93.98% (<0.0001)	Reference	
Injury/stage 2	8	30.83 (19.91, 42.90)	90.24 % (<0.0001)	0.78 (0.58, 1.06)	0.116
Not reported	9	NA	NA	NA	NA
Need for RRT					
Source of HCT					
UCB	1	2.49 (2.10, 2.91)	NA	Reference	
BM/PB	4	0.67 (0.00, 3.70)	78.53% (<0.001)	0.96 (0.54, 1.72)	0.902
BM/UCB	1	5.71 (0.10, 16.46)	NA	1.24 (0.59, 2.59)	0.571
BM/UCB/PB	19	5.01 (3.32, 7.00)	88.54% (<0.001)	1.16 (0.71, 1.89)	0.556
PB	1	10.00 (0.20, 27.83)	NA	1.47 (0.67, 3.23)	0.341
BM	4	2.78 (00.00, 17.28)	91.58% (<0.001)	1.07 (0.63, 1.85)	0.270
AKI definition's cut off					
Risk/stage 1	17	2.24 (0.92, 3.96)	74.03% (<0.001)	Reference	
Injury/stage 2	6	2.67 (0.04, 7.90)	86.97% (<0.001)	1.02 (0.82, 1.27)	0.843

AKI: Acute kidney injury; BM: Bone marrow; HCT: Hematopoietic cell transplantation; NA: Not applicable due to insufficient data; PB: Peripheral blood; RRT: Renal replacement therapy (dialysis); UCB: Umbilical cord blood; CI: confidence interval.

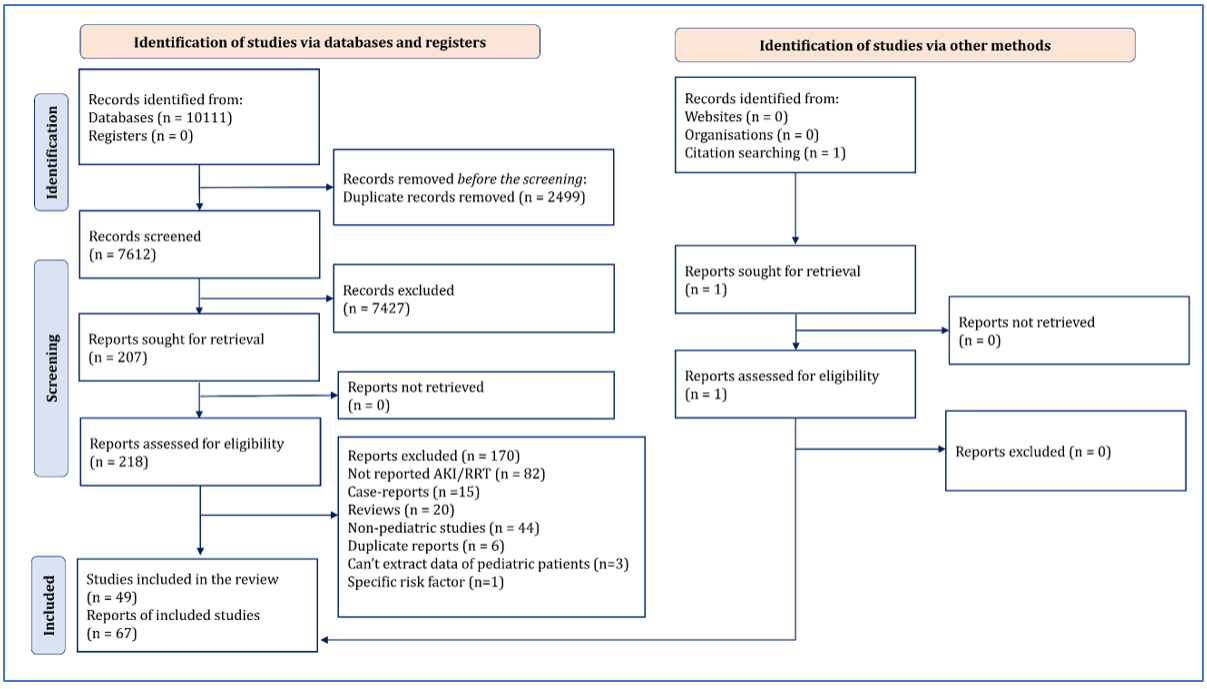


Figure 1: Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) 2020 flow diagram for screening of included studies. AKI: Acute kidney injury; RRT: Renal replacement therapy.

Table 3: Risk of bias assessment of included studies*

Author, year, country	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	overall
AlAbdullah H, 2024, Saudi Arabia (7)	Yes	Yes	NO	NA	NR	Yes	Yes	NA	NA	NA	NR	NA	Yes	NA	Poor
Ashruf OS, 2024, US (8)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Avci B, 2024, Turkey (9)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Barnoud D, 2018, France (10)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Bauer A, 2023, US (11)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Benoit SW, 2019, US (12)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Bratton SL, 2008, US (13)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Chen Z, 2025, China (14)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Cordero C, 2017, France (15)	Yes	Yes	No	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
da Cunha MM, 2022, Brazil (16)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Daraskevicius J, 2020, Lithuania (17)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Elborai Y, 2020, US (18)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Erez DL, 2020, US (19)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Farzin A, 2007, US (20)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	NR	NA	Yes	NA	Poor
Gadashova A, 2023, Turkey (21)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Gan ZP, 2022, China (22)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Gurbanov A, 2023, Turkey (23)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Hassan NE, 2013, US (24)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Hazar V, 2009, Turkey (25)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Hingorani SR, 2015, US (26)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Hirano D, 2020, Japan (27)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Ileri T, 2010, Turkey (28)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Kahn J, 2024, US (29)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Kist-van Holthe JE, 2005, Netherlands (30)***	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Kizilbash SJ, 2016, US (5)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Koh KN, 2018, US (4)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Kurokawa M, 2020, Japan (31)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Latifi A, 2024, Iran (32)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Lee SH, 2011, South Korea (33)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	NR	NA	Yes	NA	Poor
Leimi L, 2022, Finland (34)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Matbouly S, 2024, Egypt (35)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Matsuoka D, 2021, Japan (36)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes+	NA	Fair
Michael M, 2004, US (37)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Mori J, 2012, Japan (38)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Musiał K, 2021, Poland (39)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Musiał K, 2024, Poland (40)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Öztürk M, 2023, Turkey (41)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	NR	NA	Yes	NA	Poor
Prince RD, 2023, US (42)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	NR	NA	Yes	NA	Poor
Rattanaseksan K, 2025, Thailand (43)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	NR	NA	Yes	NA	Poor

Table 3: Risk of bias assessment of included studies*

Author, year, country	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	overall
Sakaguchi M, 2019, Japan (44)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Sallam DE, 2024, Egypt (45)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Sarkar N, 2024, US (46)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Satwani P, 2011, US (47)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Shi W, 2025, China (48)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Poor
Takahashi T, 2019, US (49)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	NR	NA	Yes+	NA	Poor
Wei A, 2024, China (50)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	NR	NA	Yes	NA	Poor
Yu ZP, 2010, China (51)	Yes	Yes	1-Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair
Zinter MS, 2024, US (52)	Yes	Yes	CD	NA	NR	Yes	Yes	NA	NA	NA	NR	NA	Yes	NA	Poor
Zirngibl F, 2025, Germany (53)	Yes	Yes	Yes	NA	NR	Yes	Yes	NA	NA	NA	Yes	NA	Yes	NA	Fair

1. Was the research question or objective in this paper clearly stated?
2. Was the study population clearly specified and defined?
3. Was the participation rate of eligible persons at least 50%?
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?
5. Was a sample size justification, power description, or variance and effect estimates provided?
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?
10. Was the exposure(s) assessed more than once over time?
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?
12. Were the outcome assessors blinded to the exposure status of participants?
13. Was loss to follow-up after baseline 20% or less?
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?

CD: Cannot be determined; NR: Not reported; NA: not applicable.

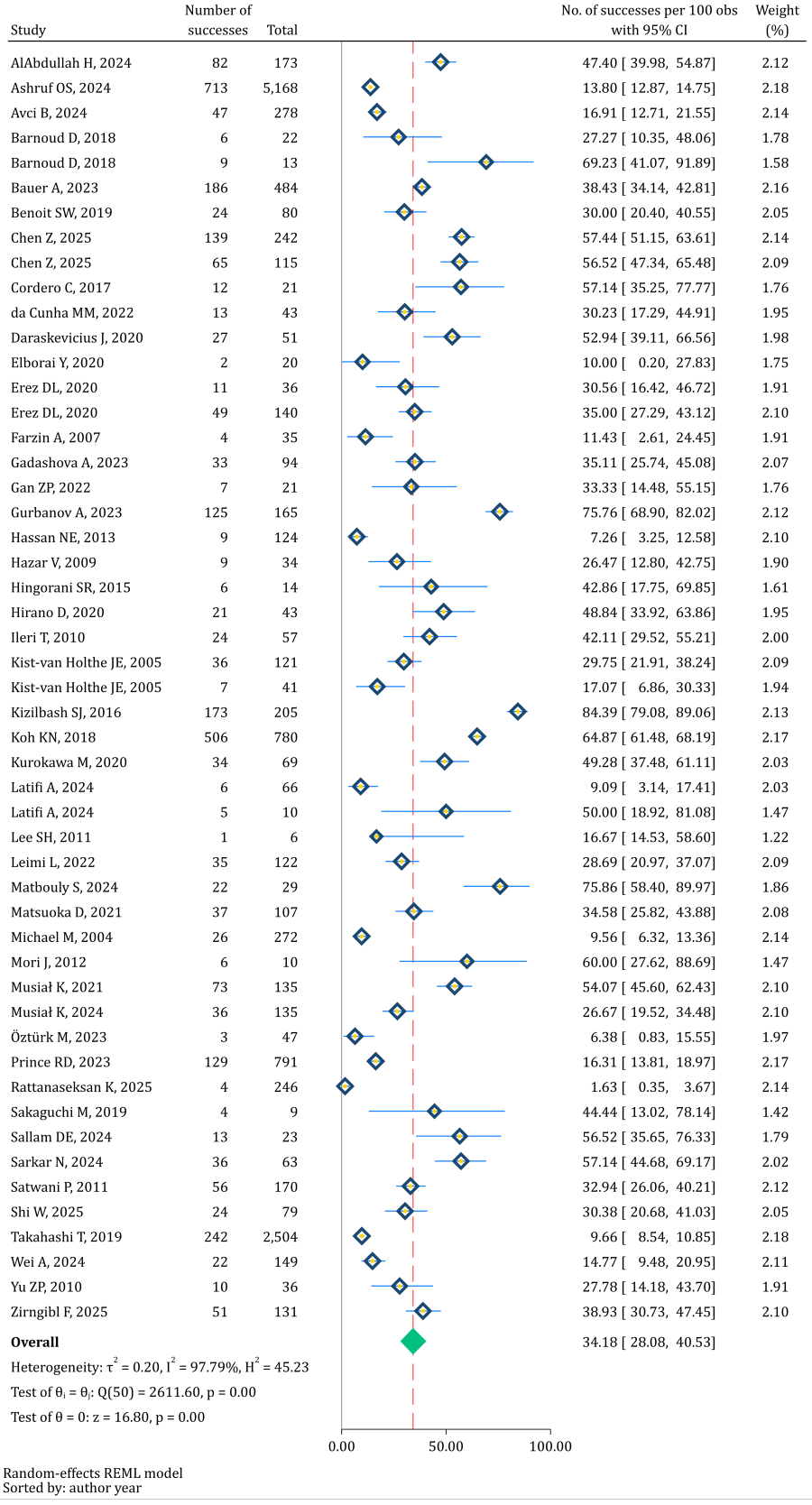


Figure 2: Prevalence of acute kidney injury (AKI) after hematopoietic stem cell transplantation. CI: Confidence interval.

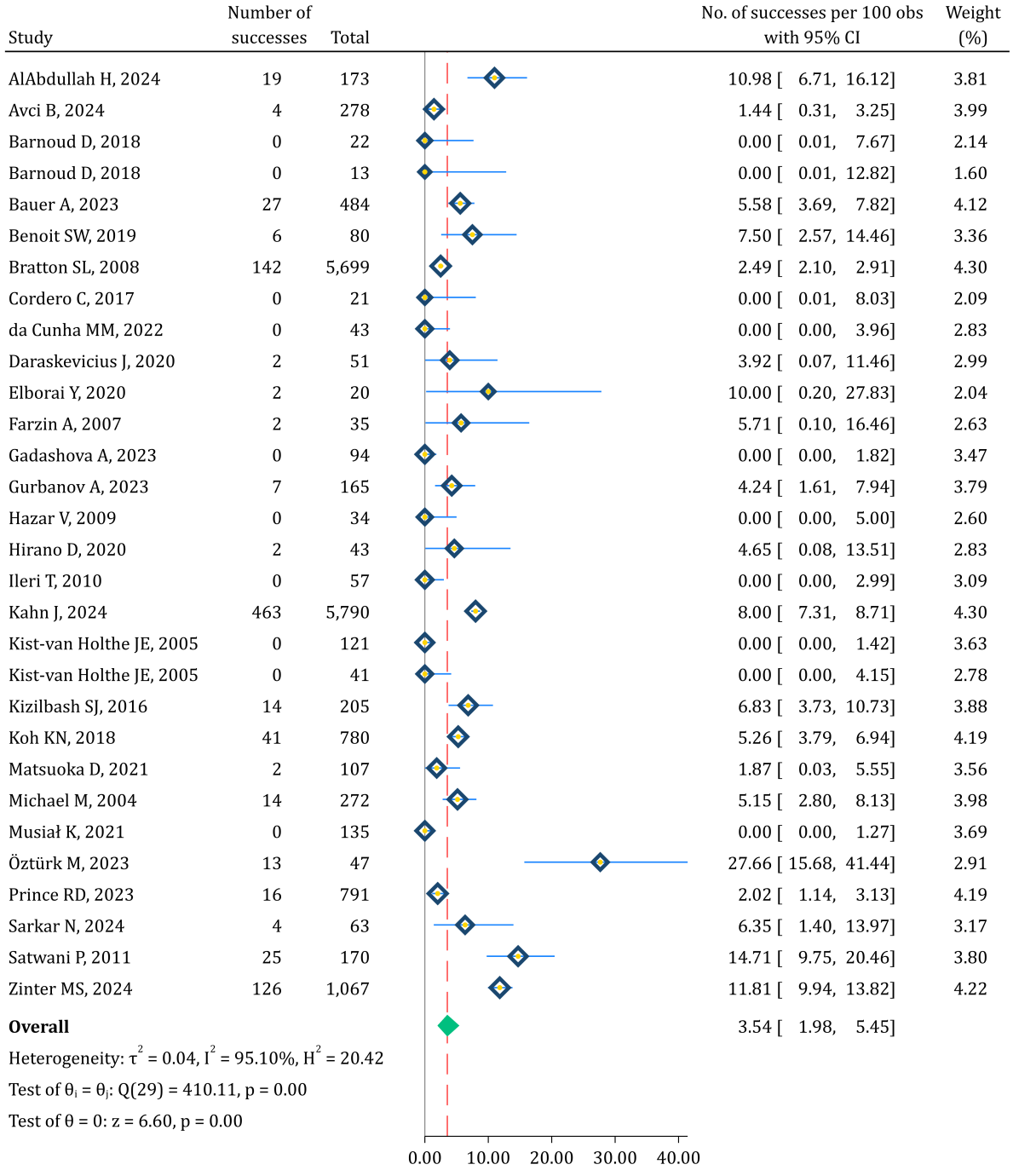
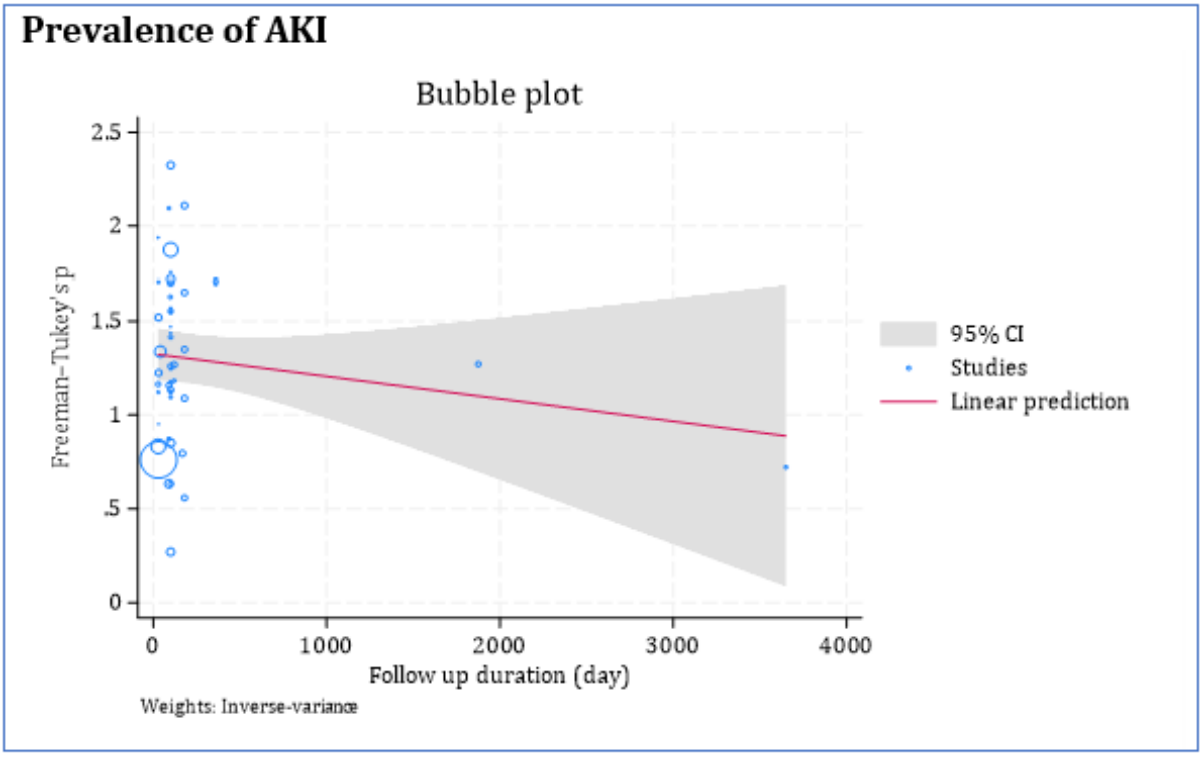


Figure 3: Prevalence of need for renal replacement therapy (RRT) after hematopoietic stem cell transplantation. CI: Confidence interval.



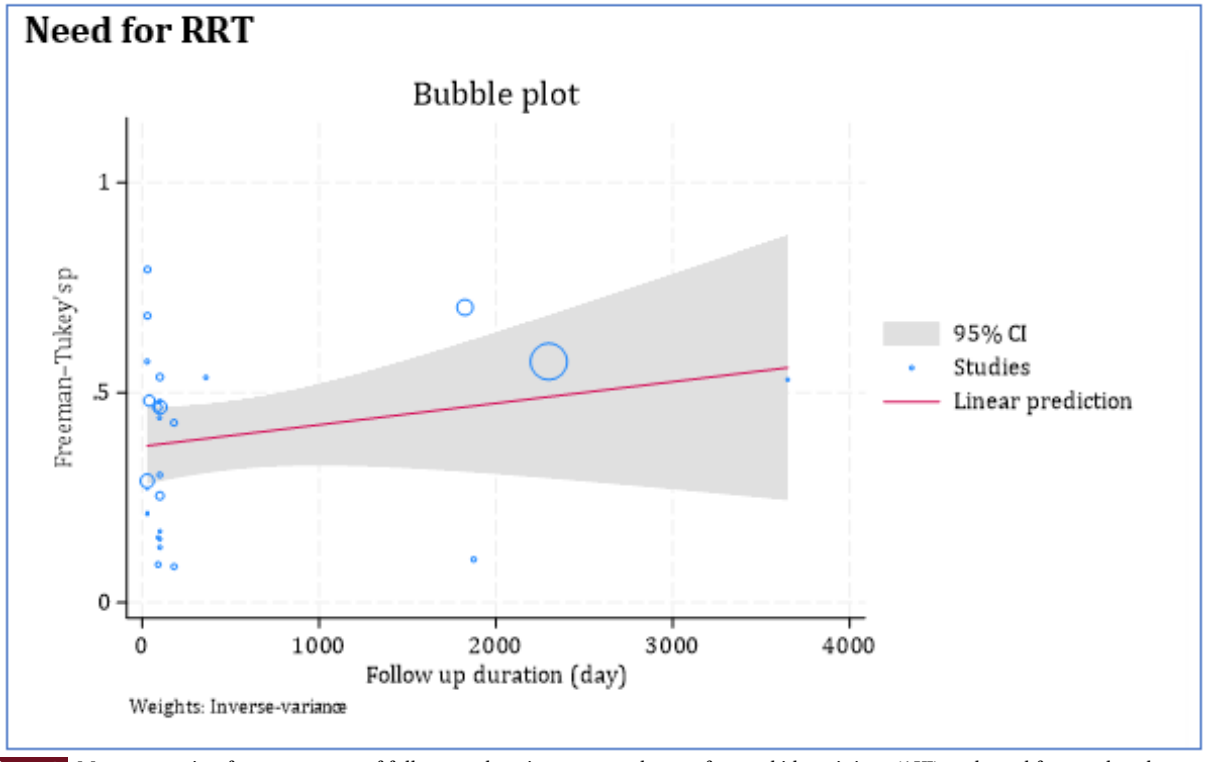
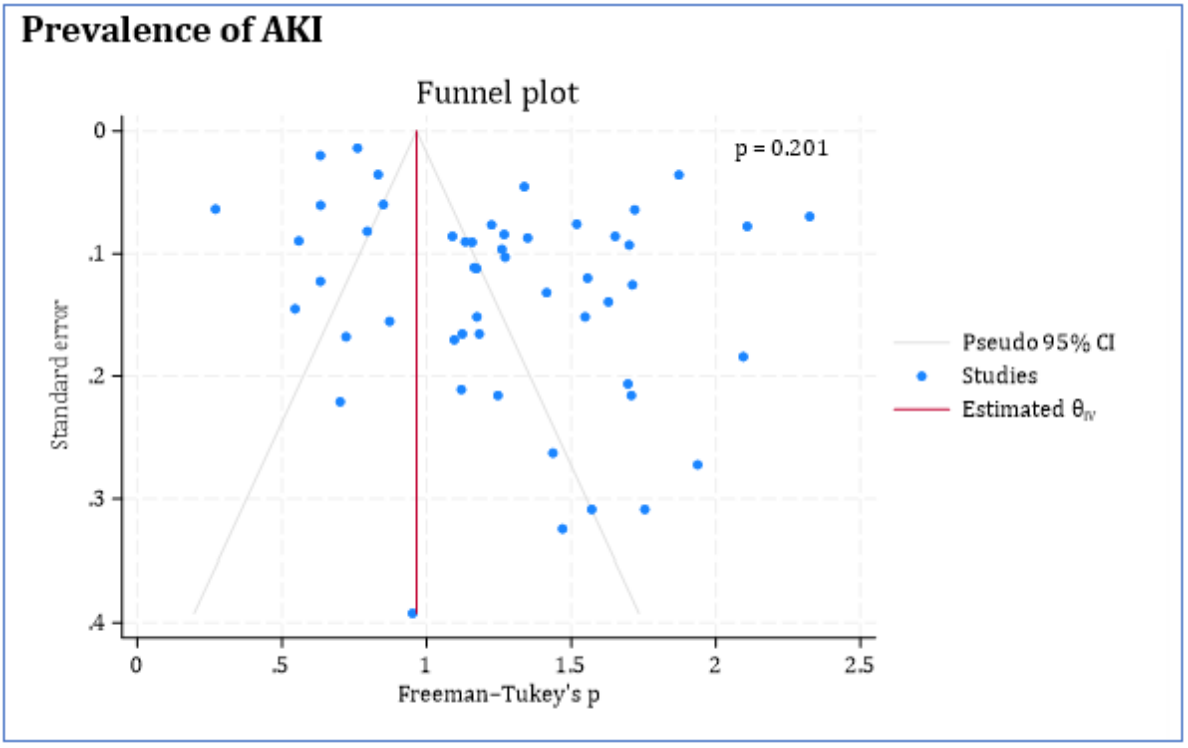


Figure 4: Meta-regression for assessment of follow-up duration on prevalence of acute kidney injury (AKI) and need for renal replacement therapy (RRT). CI: confidence interval.



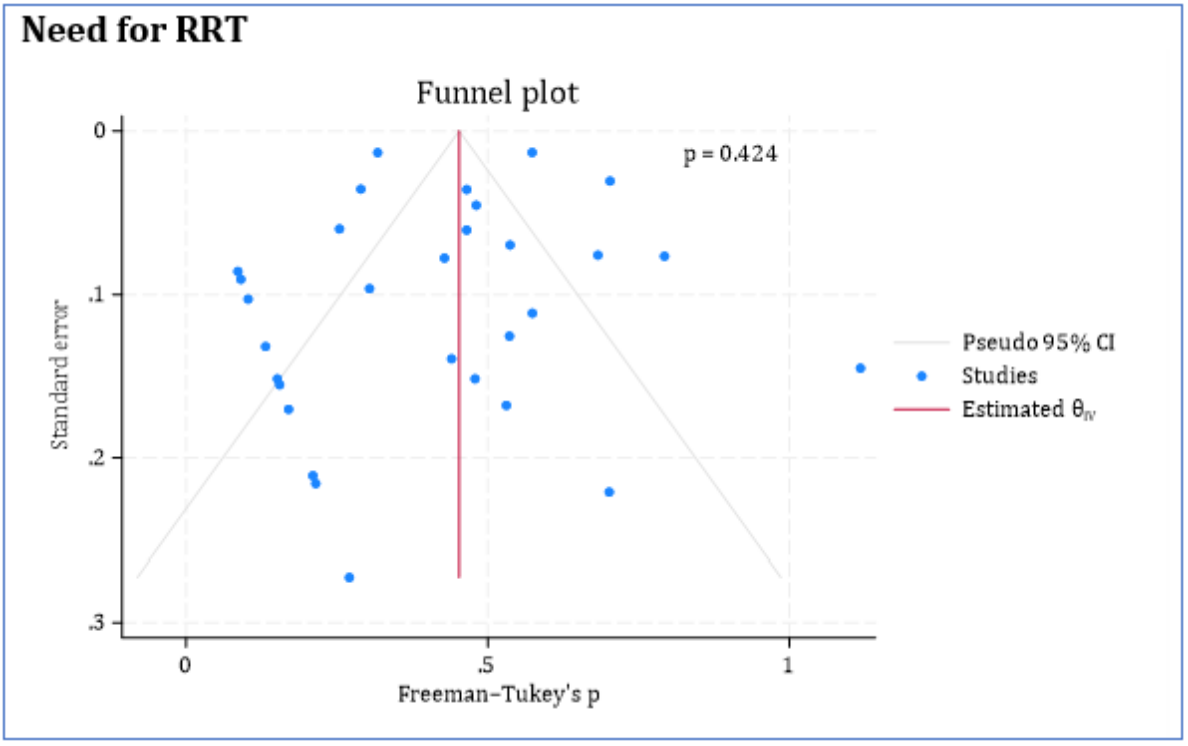


Figure 5: Publication bias in assessment of prevalence of acute kidney injury (AKI) and need for renal replacement therapy (RRT). CI: confidence interval.

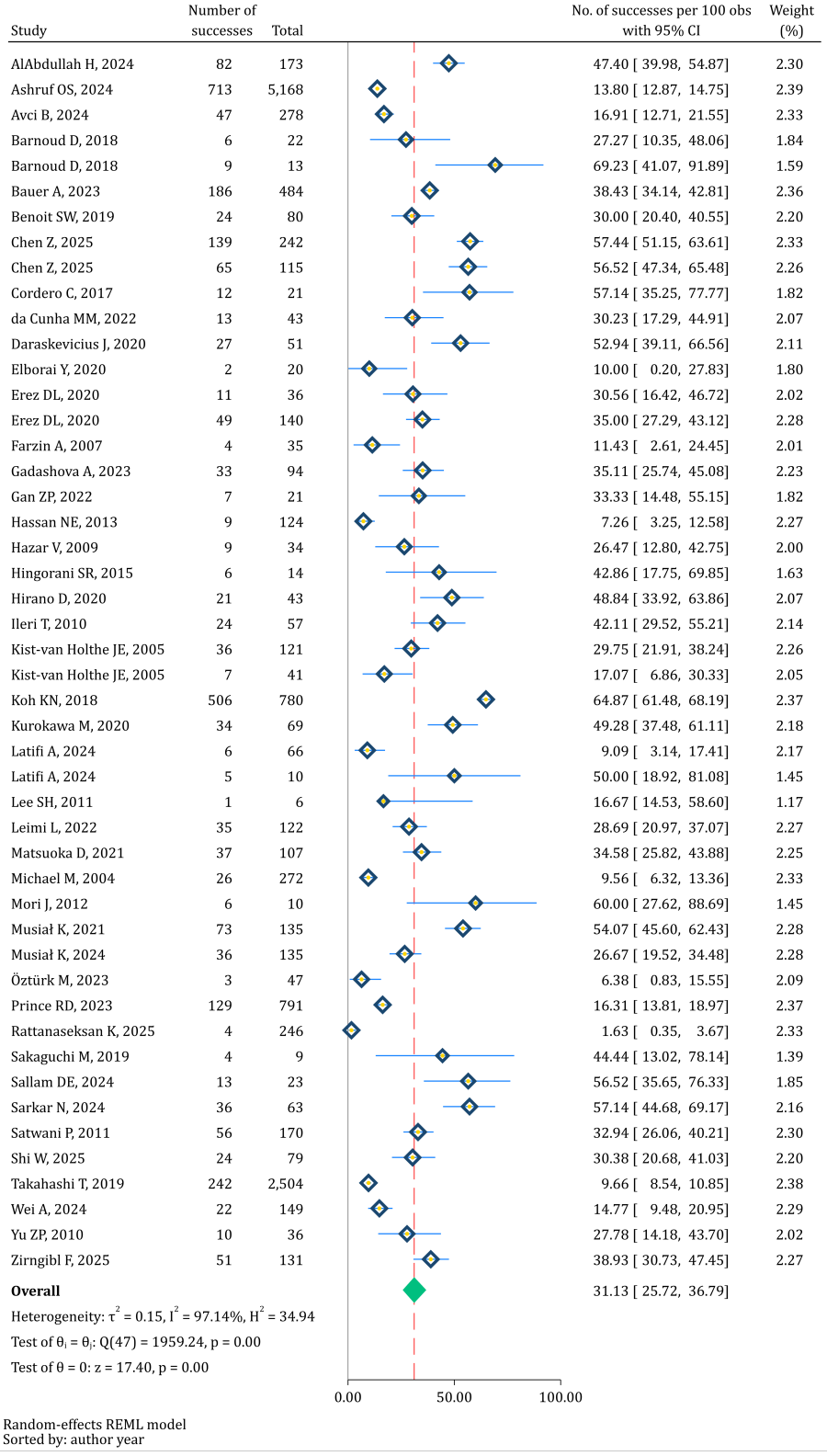


Figure 6: Sensitivity analysis for prevalence of acute kidney injury (AKI) after hematopoietic stem cell transplantation by removing studies with a prevalence of >70%. CI: Confidence interval.

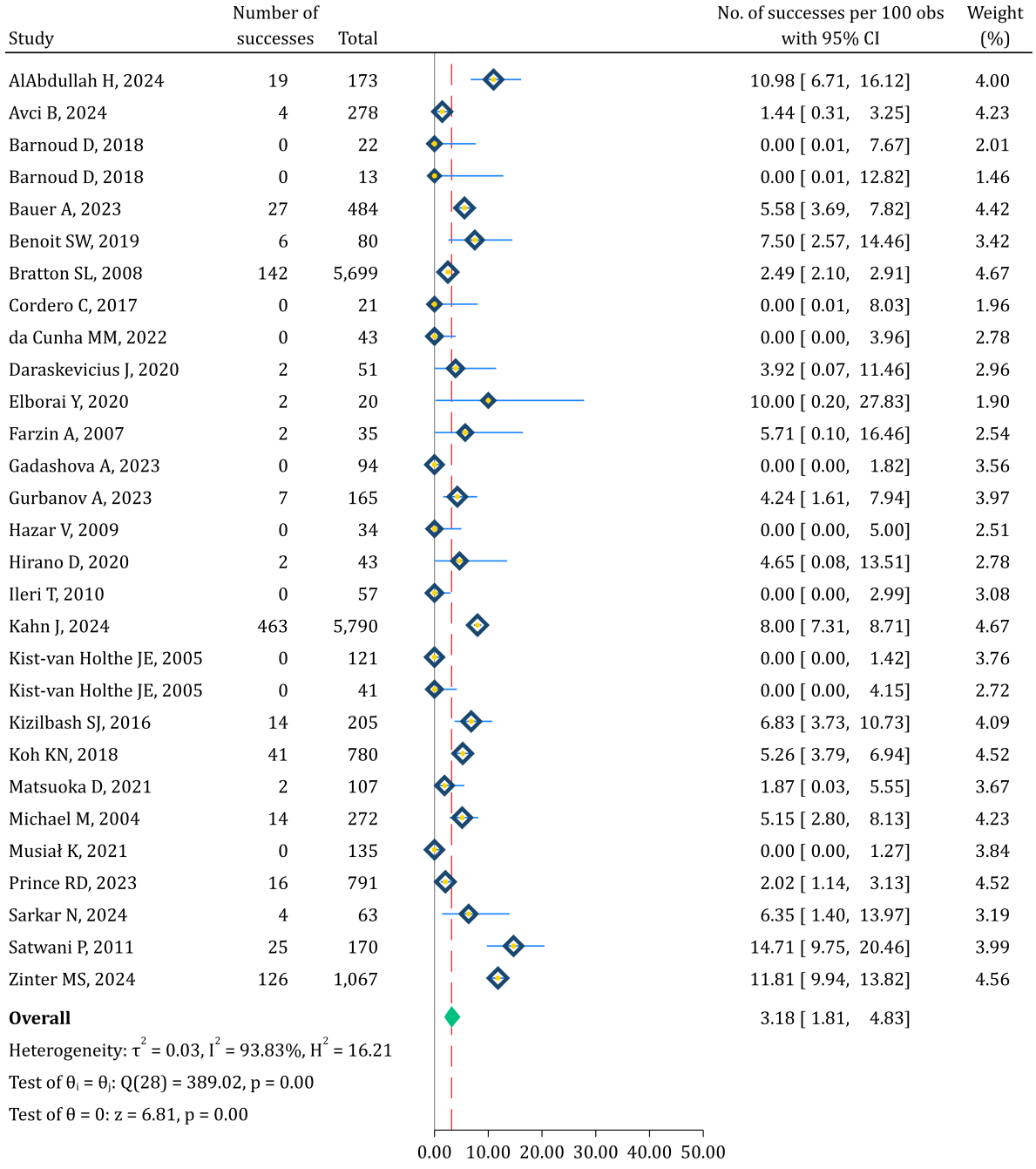


Figure 7: Sensitivity analysis for prevalence of need for renal replacement therapy (RRT) after hematopoietic stem cell transplantation by removing studies with a prevalence of >25%. CI: Confidence interval.

Appendix 1:

Medline (via PubMed)
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4- #1 AND #2 AND #3

Scopus

1- TITLE-ABS-KEY("Stem Cells" OR "Mesenchymal Stem Cell Transplantation" OR "Cord Blood Stem Cell Transplantation" OR "Monocyte-Macrophage Precursor Cells" OR "Blastomeres" OR "Pluripotent Stem Cells" OR "Fetal Stem Cells" OR "Thymocytes" OR "Precursor Cells, T-Lymphoid" OR "Precursor Cells, B-Lymphoid" OR "Hemangioblasts" OR "Megakaryocyte Progenitor Cells" OR "Megakaryocyte-Erythroid Progenitor Cells" OR "Granulocyte-Macrophage Progenitor Cells" OR "Hematopoietic Stem Cells" OR "Lymphoid Progenitor Cells" OR "Peripheral Blood Stem Cells" OR "Erythroid Precursor Cells" OR "Mesenchymal Stem Cells" OR "Stem Cell Transplantation " OR "Hematopoietic Stem Cell Mobilization" OR "Hematopoietic Stem Cell Transplantation" OR "Induced Pluripotent Stem Cells" OR "Embryonic Stem Cells" OR "Human Embryonic Stem Cells" OR "Multipotent Stem Cells" OR "Totipotent Stem Cells" OR "Myeloid Progenitor Cells" OR "Granulocyte Precursor Cells" OR "Stem Cell Transplantation" OR "Mesenchymal Stem Cell Transplantation" OR "Hematopoietic Stem Cell Transplantation" OR "Hematopoietic Stem Cells" OR "Peripheral Blood Stem Cell Transplantation" OR "allogeneic stem cell transplantation" OR " allogeneic hematopoietic stem cell transplantation" OR " allogeneic peripheral blood stem cell transplantation" OR " autologous stem cell transplantation" OR " autologous

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hematopoietic stem cell transplantation" OR " autologous stem cell transplantation" OR " autologous peripheral blood stem cell transplantation" OR " umbilical cord mesenchymal stem cell transplantation" OR " bone marrow mesenchymal stem cell transplantation" OR " limbal stem cell transplantation" OR " in utero stem cell transplantation" OR " nonmyeloablative stem cell transplantation" OR " amniotic fluid stem cell" OR " promonocytic cell" OR " endothelial progenitor cell" OR " peripheral blood stem cell" OR " erythroid precursor cell" OR " myeloid-derived suppressor cell" OR " artificial stem cell" OR " mononuclear stem cell" OR " embryonic germ cell" OR " epidermal stem cell" OR " Progenitor Cell" OR " Colony-Forming Unit" OR " Colony Forming Unit" OR " Umbilical Cord Blood Stem Cell Transplantation" OR " Placental Blood Stem Cell Transplantation" OR " Stem Cell Mobilization" OR " Mesenchymal Stem Cell" OR " Bone Marrow Mesenchymal Stem Cell" OR " Bone Marrow Stromal Cell" OR " Multipotent Bone Marrow Stromal Cell" OR " Adipose-Derived Mesenchymal Stem Cell" OR " Adipose Derived Mesenchymal Stem Cell" OR " Adipose Tissue-Derived Mesenchymal Stem Cell" OR " Adipose Tissue Derived Mesenchymal Stem Cell" OR " Adipose Tissue-Derived Mesenchymal Stromal Cell" OR " Adipose Tissue Derived Mesenchymal Stromal Cell" OR " Mesenchymal Stromal Cell" OR " Multipotent Mesenchymal Stromal Cell" OR " Mesenchymal Progenitor Cell" OR " Wharton Jelly Cells" OR " Wharton's Jelly Cell" OR " Whartons Jelly Cells" OR " Bone Marrow Stromal Stem Cells" OR " Erythroid Precursor Cell" OR " Erythroid Colony-Forming Unit" OR " CFU-E" OR " CFU E" OR " Erythroid Progenitor Cell" OR " Erythroid Stem Cell" OR " Erythropoietic Stem Cell" OR " Erythropoietic Progenitor Cell" OR " Erythroid Burst-Forming Unit" OR " BFU-E" OR " BFU E" OR " Peripheral Stem Cell" OR " Induced Pluripotent Stem Cell" OR " IPS Cell" OR " hiPSC" OR " Fibroblast-Derived Induced Pluripotent Stem Cells" OR " Fibroblast Derived Induced Pluripotent Stem Cells" OR " Fibroblast Derived IPS Cells" OR " Fibroblast-Derived IPS Cell" OR " Lymphoid Progenitor Cell" OR " Lymphoid Stem Cell" OR " Common Lymphoid Progenitor" OR " Hematopoietic Stem Cell" OR " Hematopoietic Progenitor Cell" OR " Hematopoietic Colony-Forming Unit" OR " Granulocyte-Macrophage Progenitor Cell" OR " Granulocyte Macrophage Progenitor Cell" OR " Granulocyte-Macrophage Progenitors" OR " Granulocyte Macrophage Progenitors" OR " Granulocyte-Macrophage Progenitor" OR " Granulocyte-Macrophage Colony Forming Units" OR " Granulocyte Macrophage Colony Forming Units" OR " GM-CFU" OR " CFU-GM" OR " Megakaryocyte-Erythroid Progenitor Cell" OR " Megakaryocyte Erythrocyte Progenitors" OR " Megakaryocyte-Erythrocyte Progenitor" OR " Megakaryocyte-Erythroid Progenitors" OR " Megakaryocyte-Erythroid Progenitor" OR " Megakaryocyte Progenitor Cell" OR " Megakaryocyte Progenitor" OR " Promegakaryocyte" OR " Megakaryoblast" OR " Hemangioblast" OR " Hemogenic Endothelial Cell" OR " Hemogenic Endothelium" OR " Immature B Cell" OR " B Lymphoid Precursor Cell" OR " Immature B-Lymphocyte" OR " Immature B Lymphocyte" OR " B-Lymphoid Precursor Cells" OR " Transitional B-Lymphocyte" OR " Transitional B Lymphocyte" OR " Immature B-Cell" OR " Transitional B-Cell" OR " Transitional B Cell" OR " Precursor B-Cells" OR " Precursor B Cells" OR " Precursor B-Lymphocyte" OR " Precursor B Lymphocyte" OR " Pre-B Lymphocyte" OR " Pre B Lymphocyte" OR " Pre-B Cell" OR " Pre B Cell" OR " Pre-B-Cell" OR " Precursor B-Cell" OR " Progenitor B-Cell" OR " Progenitor B Cell" OR " Pro-B Cell" OR " Pro B Cell" OR " Pro-B-Cell" OR " Pro-B Lymphocyte" OR " Pro B Lymphocyte" OR " Progenitor B-Lymphocyte" OR " Progenitor B Lymphocyte" OR " T-Lymphoid Precursor Cell" OR " T Cell Precursor" OR " T-Cell Precursor" OR " Thymocyte" OR " Fetal Stem Cell" OR " Embryonic Stem Cell" OR " hESC" OR " Human Embryonic Stem Cell" OR " Blastomere" OR " Blastocyte" OR " Pluripotent Stem Cell" OR " Multipotent Stem Cell" OR " Totipotent Stem Cell" OR " Myeloid Progenitor Cell" OR " Myeloid Stem Cell" OR " Common Myeloid Progenitor" OR " GEMM-CFU" OR " Granulocyte-Erythroid-Macrophage-Megakaryocyte Colony-Forming Unit" OR " Granulocyte Erythroid Macrophage Megakaryocyte Colony Forming Unit" OR " CFU-GEMM" OR " Granulocyte Precursor Cell" OR " Granulocytic Precursor Cell" OR " Metamyelocyte" OR " Promyelocyte" OR " Premyelocyte" OR " Progranulocyte" OR " Myeloblast" OR " Myelocyte" OR " Granulocyte Progenitor" OR " Monocyte Macrophage Precursor Cell" OR " Monocyte-Macrophage Precursor Cell" OR " Promonocyte" OR " Monoblast" OR " Monocyte Macrophage Progenitor Cell" OR " Monocyte-Macrophage Progenitor Cell" OR " stem cell based therapy" OR " stem cell therapy" OR " allogenic stem cell transplantation" OR " allo-HSC transplantation" OR " allo-HSCT" OR " allogeneic haematopoietic stem cell transplantation" OR " allogeneic hematopoietic stem cell (HSC) transplantation" OR " allogeneic HSC transplantation" OR " allogeneic HSCT" OR " allogenic haematopoietic stem cell transplantation" OR " allogenic hematopoietic stem cell (HSC) transplantation" OR " allogenic hematopoietic stem cell transplantation" OR " allogenic HSC transplantation" OR " allogenic HSCT" OR " allogeneic peripheral stem cell transplantation" OR " allogenic peripheral blood stem cell transplantation" OR " autologous stem cell therapy" OR " auto-HSC transplantation" OR " auto-HSCT" OR " autologous haematopoietic stem cell transplantation" OR " autologous hematopoietic stem cell (HSC) transplantation" OR " autologous HSC transplantation" OR " autologous HSCT" OR " autologous peripheral stem cell transplantation" OR " cord blood transplantation" OR " umbilical cord stem cell transplantation" OR " UC-MSC transplantation (UC-MSCT)" OR " UC-MSCT (umbilical cord-derived mesenchymal stem cell transplantation)" OR " umbilical cord (UC) mesenchymal stem cells transplantation (MSCT)" OR " umbilical cord (UC) -derived mesenchymal stem cells (MSCs)" OR " umbilical cord-derived mesenchymal stem cell transplantation" OR " mesenchymal stem cell therapy" OR " BMMSC transplantation" OR " bone marrow-derived mesenchymal stem cell (BMMSC) transplantation" OR " bone marrow-derived mesenchymal stem cell (BMSC) transplantation" OR " bone marrow-derived mesenchymal stem cell transplantation" OR " HSC therapy" OR " HSC transplantation" OR " in utero haematopoietic stem cell transplantation" OR " in utero hematopoietic stem cell transplantation" OR " mesenchymal stem cell therapy" OR " BMMSC transplantation" OR " non-myeloablative allogeneic stem cell transplantation" OR " non-myeloablative haematopoietic stem cell transplantation" OR " non-myeloablative hematopoietic stem cell transplantation" OR " non-myeloablative stem cell transplantation" OR " nonmyeloablative allogeneic stem cell transplantation" OR " nonmyeloablative haematopoietic stem cell transplantation" OR " nonmyeloablative hematopoietic stem cell transplantation" OR " precursor cell" OR " foetal stem cell" OR " promonocyte" OR " premonocytic cell" OR " premonocyte" OR " monocyte-macrophage precursor cell" OR " monocyte precursor" OR " monocyte macrophage precursor" OR " totipotent cell" OR " artificial progenitor cell" OR " synthetic stem cell" OR " bone marrow stem cell" OR " hemopoietic stem cell" OR " hemocytopoietic stem cell" OR " hematocytopoietic stem cell" OR " haematopoietic stem cell" OR " megakaryocyte erythroid progenitor" OR " megakaryocyte-erythroid progenitor cell" OR " Placental Blood Stem Cell Transplantation" OR " Umbilical Cord Blood Stem Cell Transplantation" OR " pluripotent cell" OR " endothelial progenitor" OR " endothelial stem cell" OR " lymphocyte precursor" OR " lymphocyte progenitor" OR " lymphoid stem cell" OR " lymphoid progenitor" OR " lymphoid precursor" OR " mesenchymal progenitor cell" OR " multipotent cell" OR " EG cell" OR " myeloid precursor" OR " myeloid stem cell" OR "

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myeloid progenitor" OR " peripheral blood precursor cell" OR " peripheral blood progenitor cell" OR " Hematopoietic Colony-Forming Unit" OR " Hematopoietic Progenitor Cell" OR " iPS cell" OR " erythroid precursor" OR " erythroid progenitor cell" OR " erythropoietic stem cell" OR " erythropoietic progenitor" OR " erythroid progenitor" OR " erythropoietic precursor" OR " MDSC cell" OR " UC-mesenchymal stem cells" OR " umbilical cord-derived mesenchymal stem cell" OR " umbilical cord MSC" OR " umbilical cord mesenchymal stem cell" OR " umbilical cord (UC) -mesenchymal stem cells (MSC)" OR " UC-MSC (umbilical cord mesenchymal stem cell)" OR " Peripheral Stem Cell Transplantation") 2- TITLE-ABS-KEY("kidney insufficiency" OR "renal insufficiency" OR "kidney dysfunction" OR "renal dysfunction" OR "kidney failure" OR "renal failure" OR "kidney injury" OR "renal injury" OR "anuresis" OR "urine absence" OR "cortex necrosis" OR "renal cortical necrosis" OR "tubular epithelium necrosis" OR "tubular necrosis" OR "kidney tubulus necrosis" OR "necrotic tubulonephrosis" OR " tubule necrosis" OR "tubulus necrosis" OR "kidney impairment" OR " renal impairment" OR "azotaemia" OR "azotemia" OR "hyperazotemia" OR "hyperuraemia" OR " hyperuremia" OR " Uraemia" OR "Glomerular Necrosis" OR "Nephroses") 3- TITLE-ABS-KEY ("Infan*" OR " newb" OR " new-b" OR "perinat*" OR "neonat* " OR "baby" OR "baby*" OR "babies" OR "toddler*" OR "min" OR " boy" OR "boys" OR "boyhood" OR "girl*" OR "kid" OR "kids" OR "child" OR "child*" OR "children*" OR "schoolchild*" OR "schoolchild" OR "school child" OR "school child*" OR "adolescen*" OR "juvenil*" OR "youth*" OR "teen*" OR "under*age*" OR "pubescen*" OR "pediatrics" OR " pediatric*" OR "paediatric*" OR "peadiatric*" OR "school" OR "school*" OR "prematur*" OR "preterm*")

4- #1 AND #2 AND #3

Web of Sciences

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OR "Hematopoietic Stem Cell Transplantation" OR "Hematopoietic Stem Cells" OR "Peripheral Blood Stem Cell Transplantation" OR "allogeneic stem cell transplantation" OR " allogeneic hematopoietic stem cell transplantation" OR " allogeneic peripheral blood stem cell transplantation" OR " autologous stem cell transplantation" OR " autologous hematopoietic stem cell transplantation" OR " autologous stem cell transplantation" OR " autologous peripheral blood stem cell transplantation" OR " umbilical cord mesenchymal stem cell transplantation" OR " bone marrow mesenchymal stem cell transplantation" OR " limbal stem cell transplantation" OR " in utero stem cell transplantation" OR " nonmyeloablative stem cell transplantation" OR " amniotic fluid stem cell" OR " promonocytic cell" OR " endothelial progenitor cell" OR " peripheral blood stem cell" OR " erythroid precursor cell" OR " myeloid-derived suppressor cell" OR " artificial stem cell" OR " mononuclear stem cell" OR " embryonic germ cell" 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Megakaryocyte-Erythroid Progenitor Cell" OR " Megakaryocyte Erythrocyte Progenitors" OR " Megakaryocyte-Erythrocyte Progenitor" OR " Megakaryocyte-Erythroid Progenitors" OR " Megakaryocyte-Erythroid Progenitor" OR " Megakaryocyte Progenitor Cell" OR " Megakaryocyte Progenitor" OR " Promegakaryocyte" OR " Megakaryoblast" OR " Hemangioblast" OR " Hemogenic Endothelial Cell" OR " Hemogenic Endothelium" OR " Immature B Cell" OR " B Lymphoid Precursor Cell" OR " Immature B-Lymphocyte" OR " Immature B Lymphocyte" OR " B-Lymphoid Precursor Cells" OR " Transitional B-Lymphocyte" OR " Transitional B Lymphocyte" OR " Immature B-Cell" OR " Transitional B-Cell" OR " Transitional B Cell" OR " Precursor B-Cells" OR " Precursor B Cells" OR " Precursor B-Lymphocyte" OR " Precursor B Lymphocyte" OR " Pre-B Lymphocyte" OR " Pre B Lymphocyte" OR " Pre-B Cell" OR " Pre B Cell" OR " Pre-B-Cell" OR " Precursor B-Cell" OR " Progenitor B-Cell" OR " Progenitor B Cell" OR " Pro-B Cell" OR " Pro B Cell" OR " Pro-B-Cell" OR " Pro-B Lymphocyte" OR " Pro B Lymphocyte" OR " Progenitor B-Lymphocyte" OR " Progenitor B Lymphocyte" OR " T-Lymphoid Precursor Cell" OR " T Cell Precursor" OR " T-Cell Precursor" OR " Thymocyte" OR " Fetal Stem Cell" OR " Embryonic Stem Cell" OR " hESC" OR " Human Embryonic Stem Cell" OR " Blastomere" OR " Blastocyte" OR " Pluripotent Stem Cell" OR " Multipotent Stem Cell" OR " Totipotent Stem Cell" OR " Myeloid Progenitor Cell" OR " Myeloid Stem Cell" OR " Common Myeloid Progenitor" OR " GEMM-CFU" OR " Granulocyte-Erythroid-Macrophage-Megakaryocyte Colony-Forming Unit" OR " Granulocyte Erythroid Macrophage Megakaryocyte Colony Forming Unit" OR " CFU-GEMM" OR " Granulocyte Precursor Cell" OR " Granulocytic Precursor Cell" OR " Metamyelocyte" OR " Promyelocyte" OR " Premyelocyte" OR " Progranulocyte" OR " Myeloblast" OR " Myelocyte" OR " Granulocyte Progenitor" OR " Monocyte Macrophage Precursor Cell" OR " Monocyte-Macrophage Precursor Cell" OR " Promonocyte" OR " Monoblast" OR "

Appendix 1:

Monocyte Macrophage Progenitor Cell" OR " Monocyte-Macrophage Progenitor Cell" OR " stem cell based therapy" OR " stem cell therapy" OR " allogenic stem cell transplantation" OR " allo-HSC transplantation" OR " allo-HSCT" OR " allogeneic haematopoietic stem cell transplantation" OR " allogeneic hematopoietic stem cell (HSC) transplantation" OR " allogeneic HSC transplantation" OR " allogeneic HSCT" OR " allogenic haematopoietic stem cell transplantation" OR " allogenic hematopoietic stem cell (HSC) transplantation" OR " allogenic hematopoietic stem cell transplantation" OR " allogenic HSC transplantation" OR " allogenic HSCT" OR " allogeneic peripheral stem cell transplantation" OR " allogenic peripheral blood stem cell transplantation" OR " autologous stem cell therapy" OR " auto-HSC transplantation" OR " auto-HSCT" OR " autologous haematopoietic stem cell transplantation" OR " autologous hematopoietic stem cell (HSC) transplantation" OR " autologous HSC transplantation" OR " autologous HSCT" OR " autologous peripheral stem cell transplantation" OR " cord blood transplantation" OR " umbilical cord stem cell transplantation" OR " UC-MSC transplantation (UC-MSCT)" OR " UC-MSCT (umbilical cord-derived mesenchymal stem cell transplantation)" OR " umbilical cord (UC) mesenchymal stem cells transplantation (MSCT)" OR " umbilical cord (UC) -derived mesenchymal stem cells (MSCs)" OR " umbilical cord-derived mesenchymal stem cell transplantation" OR " mesenchymal stem cell therapy" OR " BMMSC transplantation" OR " bone marrow-derived mesenchymal stem cell (BMMSC) transplantation" OR " bone marrow-derived mesenchymal stem cell (BMSC) transplantation" OR " bone marrow-derived mesenchymal stem cell transplantation" OR " HSC therapy" OR " HSC transplantation" OR " in utero haematopoietic stem cell transplantation" OR " in utero hematopoietic stem cell transplantation" OR " mesenchymal stem cell therapy" OR " BMMSC transplantation" OR " non-myeloablative allogeneic stem cell transplantation" OR " non-myeloablative haematopoietic stem cell transplantation" OR " non-myeloablative hematopoietic stem cell transplantation" OR " non-myeloablative stem cell transplantation" OR " nonmyeloablative allogeneic stem cell transplantation" OR " nonmyeloablative haematopoietic stem cell transplantation" OR " nonmyeloablative hematopoietic stem cell transplantation" OR " precursor cell" OR " foetal stem cell" OR " promonocyte" OR " premonocytic cell" OR " premonocyte" OR " monocyte-macrophage precursor cell" OR " monocyte precursor" OR " monocyte macrophage precursor" OR " totipotent cell" OR " artificial progenitor cell" OR " synthetic stem cell" OR " bone marrow stem cell" OR " hemopoietic stem cell" OR " hemocytopoietic stem cell" OR " hematocytopoietic stem cell" OR " haematopoietic stem cell" OR " megakaryocyte erythroid progenitor" OR " megakaryocyte-erythroid progenitor cell" OR " Placental Blood Stem Cell Transplantation" OR " Umbilical Cord Blood Stem Cell Transplantation" OR " pluripotent cell" OR " endothelial progenitor" OR " endothelial stem cell" OR " lymphocyte precursor" OR " lymphocyte progenitor" OR " lymphoid stem cell" OR " lymphoid progenitor" OR " lymphoid precursor" OR " mesenchymal progenitor cell" OR " multipotent cell" OR " EG cell" OR " myeloid precursor" OR " myeloid stem cell" OR " myeloid progenitor" OR " peripheral blood precursor cell" OR " peripheral blood progenitor cell" OR " Hematopoietic Colony-Forming Unit" OR " Hematopoietic Progenitor Cell" OR " iPS cell" OR " erythroid precursor" OR " erythroid progenitor cell" OR " erythropoietic stem cell" OR " erythropoietic progenitor" OR " erythroid progenitor" OR " erythropoietic precursor" OR " MDSC cell" OR " UC-mesenchymal stem cells" OR " umbilical cord-derived mesenchymal stem cell" OR " umbilical cord MSC" OR " umbilical cord mesenchymal stem cell" OR " umbilical cord (UC) -mesenchymal stem cells (MSC)" OR " UC-MSC (umbilical cord mesenchymal stem cell)" OR " Peripheral Stem Cell Transplantation")

2- TS=("kidney insufficiency" OR "renal insufficiency" OR "kidney dysfunction" OR "renal dysfunction" OR "kidney failure" OR "renal failure" OR "kidney injury" OR "renal injury" OR "anuresis" OR "urine absence" OR "cortex necrosis" OR "renal cortical necrosis" OR "tubular epithelium necrosis" OR "tubular necrosis" OR "kidney tubulus necrosis" OR "necrotic tubulonephrosis" OR " tubule necrosis" OR "tubulus necrosis" OR "kidney impairment" OR " renal impairment" OR "azotaemia" OR "azotemia" OR "hyperazotemia" OR "hyperuraemia" OR " hyperuremia" OR " Uraemia" OR "Glomerular Necrosis" OR "Nephroses")

3- TS= ("Infan*" OR " newb*" OR " new-b*" OR " perinat* " OR " neonat* " OR " baby " OR " baby* " OR " babies " OR " toddler* " OR " min" OR " boy " OR " boys " OR " boyhood " OR " girl* " OR " kid " OR " kids " OR " child " OR " child* " OR " children* " OR " schoolchild* " OR " schoolchild " OR " school child " OR " school child* " OR " adolescen* " OR " juvenil* " OR " youth* " OR " teen* " OR " under*age* " OR " pubescen* " OR " pediatrics" OR " pediatric* " OR " paediatric* " OR " peadiatric* " OR " school " OR " school* " OR " prematur* " OR " preterm*")

4- #1 AND #2 AND #3