

## The impact of timing of renal replacement therapy on the outcome of acute kidney injury in critically ill patient: a meta-analysis

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**Abstract: Background:** Acute kidney injury (AKI) is a common complication in the critically ill patients and associated with a substantial morbidity and mortality. Renal replacement therapy (RRT) remains the primary supportive management strategy for patients with severe AKI. However; the exact timing of initiation of RRT for better patient outcome is still debatable with conflicting data from randomized controlled trials. Thus, a systematic review and meta-analysis was performed to assess the impact of “early” versus “late” initiation of RRT. **Objectives:** To investigate the impact of timing of initiation of renal replacement therapy (RRT) on clinical outcomes in critically ill patients with acute kidney injury (AKI), focusing on the randomized controlled trials in this field. **Methods:** We enrolled 9 RCTs (since 2000 till 2019) with a total of 1636 patients in this Meta-analysis randomized as early and late groups focusing on mortality up to 90 days, intensive care unit LOS among survivors and non-survivors, hospital LOS among survivors and non-survivors, renal function recovery and renal replacement therapy dependence. The most fundamental differences among the trials were the large differences concerning the timing of RRT initiation among studies. Urine output, serum creatinine, serum urea nitrogen and AKI stages were not used unified in the individual studies to define the early and late RRT strategies. **Results:** A pooled analysis of the studies indicated no mortality benefit with “early” RRT, with an RR of 0.97 (95% CI 0.87 to 1.09, P = 0.010). There was no significant difference in intensive care unit (ICU) length of stay (LOS) or hospital LOS between the early and late RRT groups for survivors or non-survivors. Pooled analysis also demonstrated no significant change in renal function recovery (RR 0.99, 95% CI 0.91 to 1.07, I<sup>2</sup> = 58.878%), RRT dependence (RR 0.76, 95% CI 0.42 to 1.37, I<sup>2</sup> = 0%). **Conclusion:** Our meta-analysis revealed that the “early” initiation of RRT in critically ill patients did not result in a reduced Mortality. A pooled analysis of secondary outcomes Showed no significant difference in Intensive care unit Length of stay (LOS) or hospital Length of stay (LOS) between early and late RRT group for survivors or non- survivors. A pooled analysis also demonstrated no significant change in renal function recovery and RRT dependence.

[Ahmed Elshaer, Rania Magdy Mohamed, Hany Magdy Fahim, Mahmoud Omar. **The impact of timing of renal replacement therapy on the outcome of acute kidney injury in critically ill patient: a meta-analysis.** *N Y Sci J* 2019;12(8):7-18]. ISSN 1554-0200 (print); ISSN 2375-723X (online). <http://www.sciencepub.net/newyork>. 2. doi:[10.7537/marsnys120819.02](https://doi.org/10.7537/marsnys120819.02).

**Key Words:** Acute kidney injury, renal replacement therapy, Length of stay

### 1. Introduction:

Acute kidney injury (AKI) is a common potentially life threatening complication of illnesses among 1% of the community-based population, 8–15% of hospitalized patients, and up to 50% of critically ill patients admitted to the intensive care unit (ICU) (1).

AKI carries increased risk of morbidity and mortality and adds to the health- care cost, even in mild temporary form (2).

Although renal replacement therapy (RRT) remains the primary supportive management strategy for patients with severe AKI, it could also be associated with complications and adverse events (3).

Despite improvements in RRT technology, it is still not clear whether the outcome of patients with AKI who require RRT has improved over the years (4).

Earlier initiation of RRT may provide a better control of fluid and electrolyte balance, superior acid–base homeostasis, removal of uremic waste, and prevention of subsequent complications attributable to AKI. Furthermore, earlier RRT could potentially limit the kidney-specific and remote organ injuries due to fluid overload, electrolyte imbalance, and systemic inflammation (5).

However, earlier RRT may also expose the patients to increased risks of hemodynamic instability, anticoagulation induced bleeding, blood stream infection, and even inflammatory or oxidative stress induced by the bio-incompatibility of the dialyzer membranes.

In comparison, later initiation of RRT may allow more time for hemodynamic optimization prior to RRT, and it may avoid the need for RRT and its associated complications (6).

In recent decades, the timing of RRT initiation has been evaluated in different population types (e. g., surgical or medical patients). Variability in the definitions of AKI and RRT timing has resulted in contradicting conclusions among the various studies (7).

Similarly, previous systematic analyses regarding the optimal timing of RRT initiation were unable to draw definitive conclusions owing to the scarcity of large-scale randomized controlled trials (RCTs), non-standardized triggers for RRT initiation, and heterogeneities of population and study design while the observational studies tended to show more beneficial effects for earlier RRT, clinical trials were unable to replicate these findings (8).

Recently, two large RCTs showed contradictory results and attracted considerable attention from both clinicians and researchers. The first was a multicenter RCT by the AKIKI study group, which showed no significant differences in 60-day mortality between early and delayed RRT groups (8).

Another was the ELAIN trial, (9) a single-center RCT that showed significant benefits in terms of 90-day mortality, renal function recovery, and hospital length of stay (LOS) among patients in the early RRT group. Although these two RCTs exhibited opposing results, they added value to the field of critical care (9).

This systematic review is conducted to include all relevant RCTs related to the impact of the timing of RRT initiation among critically ill patients with moderate to severe AKI.

## 2. Patients and methods:

### Studies and participants

In the current meta-analysis, we searched for interventional clinical trials in critically ill adult patients evaluated to have Acute Kidney Injury.

### Search strategy for identification of the studies

Electronic search was conducted in PubMed, Scopus, Google scholar and Cochrane library and then the relevant articles and studies were identified and obtained.

### Inclusion criteria were:

1. Adult critically ill patient  $\geq 18$  years old.
2. Having acute kidney injury.
3. Randomized controlled trials.
4. Clearly comparing early versus late RRT initiation with effect on mortality and clinically relevant secondary outcomes.

### Exclusion criteria were:

Between 23 studies 14 study were excluded for all the following measures:

- Not randomized controlled trials.
- Early and late RRT criteria are unclear.
- Lack of mortality data.
- Studies without clear comparison of the outcomes.

While the other 9 studies were included in the current meta-analysis as they fulfilled the inclusion criteria.

### Characteristics of the studies:

**Table (1):** Basic Characteristics of Studies Included in Meta-analysis.

Study	Country	Period	Study design	Duration of follow up (days)	Number of patients		
					Total	Early	Late
<b>Bouman et al., 2002 (10)</b>	Netherland	1998-2000	Two center	28	106	70	36
<b>Durmaz et al.,2003 (11)</b>	Turkey	1999–2001	Single center	30	44	21	23
<b>Sugahara and suzuki,2004 (12)</b>	Japan	1995–1997	Single center	14	28	14	14
<b>Payen et al.,2009 (13)</b>	France	1997-2000	Multi center	28	76	37	39
<b>Jamale et al.,2013 (14)</b>	India	2010–2012	Single center	90	208	102	106
<b>Combes et al.,2015 (15)</b>	France	2009–2012	Multi center	90	224	112	112
<b>Wald et al.,2015 (16)</b>	Canada	2012–2013	Multi center	90	100	48	52
<b>Gaudry et al.,2016</b>	France	2013–2016	Multi center	60	619	311	308
<b>Zarbock et al.,2016</b>	Germany	2013–2015	Single center	90	231	112	119

**Table (2):** Age and sex among the included studies

Study	Total	Mean age (years)		Male %	
		Early	Late	Early	Late
Bouman et al., 2002	106	68	67	57	61
Durmaz et al.,2003	44	58	54	76	83
Sugahara and suzuki,2004	28	65	64	64	64
Payen et al.,2009	76	58	59	73	69
Jamale et al.,2013	208	43	42	61	75
Combes et al.,2015	224	61	58	79	80
Wald et al.,2015	100	62	64	73	71
Gaudry et al.,2016	619	65	67	67	64
Zarbock et al.,2016	231	66	68	70	57

A total of 1636 patients were enrolled. Of these studies, four of the studies were multi-center studies (*Payen et al., 2009- Combes et al., 2015- Wald et al., 2015- Gaudry et al., 2016*).

Four were single-center studies (*Durmaz et al., 2003- Sugahara and suzuki,2004- Jamale et al., 2013- Zarbock et al., 2016*), and one was a two-center study (*Bouman et al., 2002*).

Three studies examined only patients following cardiac surgery (*Durmaz et al., 2003- Sugahara and*

*suzuki,2004-Combes et al., 2015*), whereas the remaining six studies were mixed with medical or surgical patients.

The follow-up time reported in these studies ranged from 14 to 90 days (**table 1**). Age and sex are demonstrated in (**table 2**).

The definition of early and late initiation of RRT for each specific study is outlined in (**Table 3**).

**Table (3):** Definition of Early and Late RRT in Studies Included in the Meta-analysis

Author	Early criteria	Late criteria	MODALITY
Bouman2002	RRT within 12 h if urine output <30 ml/h, Cr clearance <20 ml/min, and mechanical ventilation	Urea > 40 mmol/L or K > 6.5 mmol/L or severe pulmonary edema	CVVH
Durmaz 2003	Preoperative prophylactic RRT in all patients and postoperative s Cr increased >10%	Postoperative sCr increased >50% or urine output <400 ml/24 h	IHD
Sugahara and suzuki,2004	Urine output <30 ml/h for 3 h or urine output <750 ml/day	Urine output <20 ml/h for 2 h or urine output <500 ml/day	CVVH
Payen2009	RRT for 96-h period within 24 h of diagnosis of severe sepsis	Classic indications for RRT (azotemia, fluid overload, acidosis, and hyperkalemia)	CVVH
Jamale2013	Serum urea nitrogen >70 mg/dL and/or creatinine>7 mg/dL	Classic indications for RRT or Uremic nausea and anorexia	IHD
Combes2015	RRT within 24 h of diagnosis of post-cardiac surgery shock	Creatinine>4 mg/dL or preoperative creatinine × 3 or UOP<0.3 ml/kg/h /24 h or urea >36 mmol/L or life-threatening hyperkalemia	CVVH
Wald2015	sCr increased >200%, urine output <6 ml/kg within 12 h, or NGAL ≥ 400 ng/ml	K > 6.0 mmol/L or serum bicarbonate <10 mmol/L or pulmonary Edema	IHD/CVVH/SLEDD
Gaudry2016	RRT within 6 h of diagnosis of KDIGO stage 3	K > 6.0 mmol/L or PH < 7.15 or pulmonary edema or blood urea nitrogen >112 mg/dL or oliguria >72 h	IHD/CVVH
Zarbock2016	RRT within 8 h of diagnosis of KDIGO stage 2	RRT within 12 h of KDIGO stage 3 or no RRT	CVVH

Five studies used urine output and/or serum creatinine or serum urea nitrogen or creatinine clearance for defining early and late RRT (*Wald et al., 2015-Durmaz et al., 2003-Sugahara and Suzuki, 2004-Jamale et al., 2013-Bouman et al., 2002*), two studies started early RRT with diagnosis of severe sepsis or post-cardiac surgery shock (*Payen et al., 2009-Combes et al., 2015*) and the latest two studies in 2016 used Kidney Disease: Improving Global Outcomes (KIDGO) stage 2 or stage 3 to define early RRT (*Gaudry et al., 2016-Zarbock et al., 2016*).

In most of the studies, late RRT was defined as a classic indication, including azotemia, oliguria, pulmonary edema, hyperkalemia and metabolic acidosis. The individual studies defined early and late RRT by using variable cutoff values in serum creatinine or urine output (**table 3**).

#### **Interventions:**

In the current meta-analysis, we considered all studies reporting the timing of renal replacement therapy early versus late in all medical and surgical patients. The modality of RRT varied significantly among the individual studies (**table 3**).

The modality of continuous vena-venous hemofiltration (CVVH) was used in five studies (*Bouman et al., 2002-Sugahara and Suzuki, 2004-Payen et al., 2009-Combes et al., 2015 and Zarbock et al., 2016*) and intermittent hemodialysis (IHD) was used in two studies (*Durmaz et al., 2003 and Jamale et al., 2013*). In the remaining two studies, some of the patients received CVVH modality, and the others received IHD or sustained low-efficiency dialysis (SLED) modality (*Gaudry et al., 2016 and Wald et al., 2015*).

#### **Outcome measures:**

The primary outcome was

1- Mortality, Including 14-day mortality, 28-day mortality, 30-day mortality, 60-day mortality, 90-day mortality, ICU mortality, and in-hospital mortality. The longest follow-up mortality reported in the individual studies was extracted for the pooling analysis.

Secondary outcomes included

- 2- The ICU length of stay (LOS) in survivors and non survivors
- 3- Hospital LOS in survivors and non survivors
- 4- Renal function recovery
- 5- Renal replacement therapy dependence.

#### **Study selection:**

One reviewer (MO) checked all identified titles and abstracts and other reviewer (HM) validated this check. The 2 reviewers examined all potential trials and graded their methodological quality. Any disagreement within or between reviewers was resolved by discussion with each other.

#### **Data extraction:**

One reviewer (MO) drew up a standard data extraction form and other reviewer (HM) validated it.

#### **Statistical Methods for Meta-Analysis:**

Meta-analysis was performed using Comprehensive Meta-Analysis version 3.0 software. In case of quantitative outcomes Mean±SD and total sample count were collected then the mean differences were pooled to calculate the weighted mean, while in case of qualitative outcomes, events and total sample count were collected then the relative rates were pooled to calculate the weighted relative rate. Forest plots were used to present the individual and weighted estimates. Heterogeneity ( $I^2$ ) index was calculated to test variation of pooled estimates for each outcome, and presented by Funnel plot. The level of significance was taken at P value < 0.050 is significant, otherwise is non-significant.

### **3. Results:**

#### **Primary outcome:**

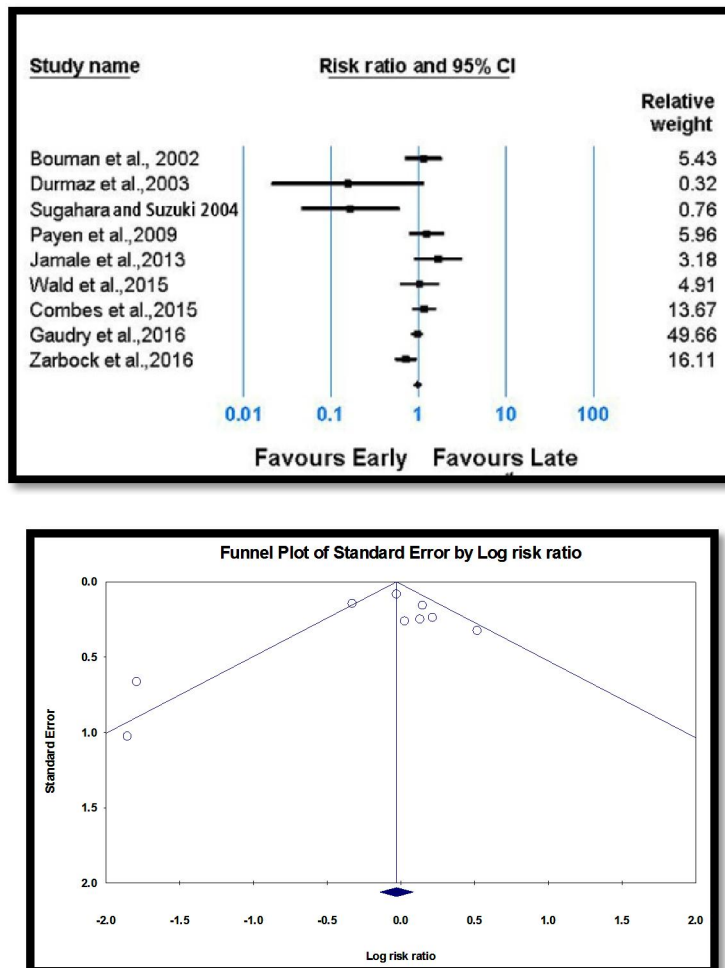
##### 1-Mortality

Table (4) and figure (1,2) show that: The mortality was reported in the nine included studies. There was significant heterogeneity among these studies. Thus, we performed the statistics using a random-effects model, and the results showed that mortality was not significantly different between early and late interventions.

**Table (4):** Meta-analysis for mortality.

Study	Early (event/total)			Late (event/total)			RR (95% CI)	P
	Total	N	%	Total	N	%		
Bouman et al., 2002	70	31	44.3	36	14	38.9	1.14 (0.70–1.85)	0.601
Durmaz et al., 2003	21	1	4.8	23	7	30.4	0.16 (0.02–1.17)	0.070
Sugahara and Suzuki, 2004	14	2	14.3	14	12	85.7	0.17 (0.05–0.61)	<b>0.007*</b>
Payen et al., 2009	37	20	54.1	39	17	43.6	1.24 (0.78–1.97)	0.364
Jamale et al., 2013	102	21	20.6	106	13	12.3	1.68 (0.89–3.17)	0.110
Wald et al., 2015	48	18	37.5	52	19	36.5	1.03 (0.62–1.71)	0.921
Combes et al., 2015	112	51	45.5	112	44	39.3	1.16 (0.85–1.58)	0.345
Gaudry et al., 2016	311	150	48.2	308	153	49.7	0.97 (0.83–1.14)	0.719
Zarbock et al., 2016	112	44	39.3	119	65	54.6	0.72 (0.54–0.95)	<b>0.022*</b>
Overall effect	--			--			0.97 (0.87–1.09)	0.611 (z=0.509)
Heterogeneity	I <sup>2</sup>			60.405			P	<b>0.010*</b>

RR: Relative rate, CI: Confidence interval, \*Significant



**Figure (2):** Funnel plot for mortality

**Secondary outcomes:**  
 2- ICU length of stay.  
**Survivors**

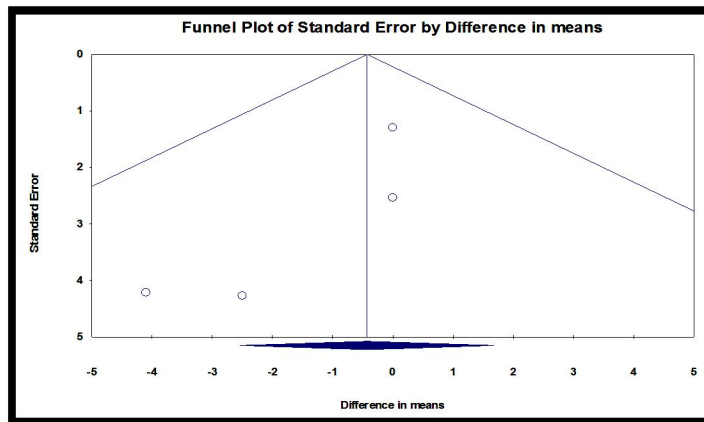
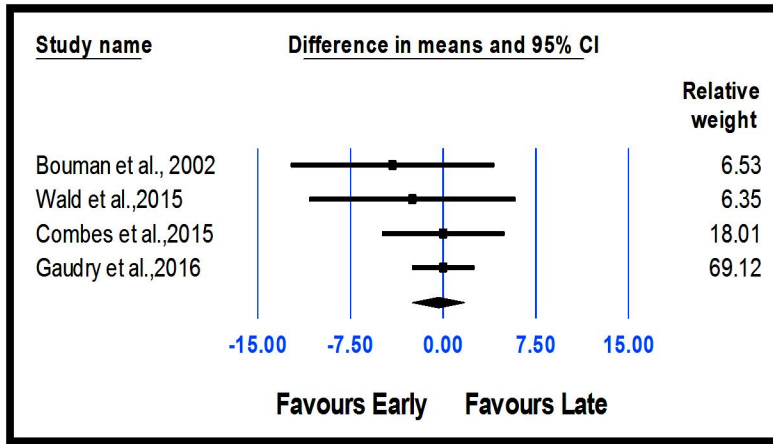
Table (5) and figures (3,4) show that: ICU stay among survivors was reported in the four included studies. There was no significant heterogeneity among these studies. Thus, we performed the statistics using a

fixed-effects model, and the results showed that ICU stay among survivors was not significantly different between early and late interventions.

**Table (5):** Meta-analysis for ICU stay (days) among survivors.

Study	Effects				Difference		P
	Early		Late		Mean±SE	95%CI	
	N	Mean±SD	N	Mean±SD			
Bouman et al., 2002	47	10.9±19.9	26	15.0±10.7	-4.1±4.2	-12.4–4.2	0.330
Wald et al.,2015	30	11.0±15.9	33	13.5±17.8	-2.5±4.3	-10.9–5.9	0.558
Combes et al.,2015	63	13.0±13.3	69	13.0±15.6	0.0±2.5	-5.0–5.0	1.000
Gaudry et al.,2016	161	13.0±11.1	155	13.0±11.9	0.0±1.3	-2.5–2.5	1.000
<b>Overall effect</b>					-0.4±1.1	-2.5–1.7	0.692 (z=0.396)
<b>Heterogeneity</b>		<b>I<sup>2</sup></b>		0.000	<b>P</b>		0.799

RR: Relative rate, CI: Confidence interval, \*Significant



**Figure (4):** Funnel plot for ICU stay among survivors

**Non Survivors**

Table (6) and figure (5) show that: ICU stay among non-survivors was reported in the two included studies. There was no significant heterogeneity among

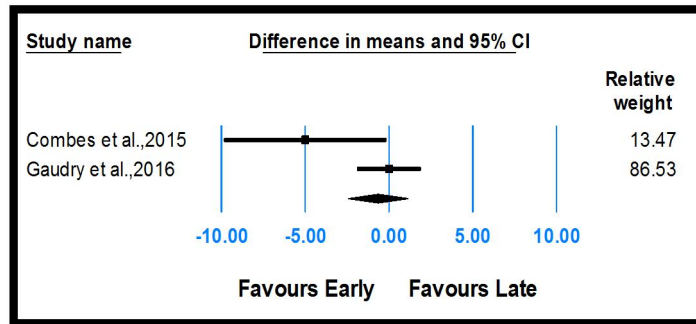
these studies. Thus, we performed the statistics using a fixed-effects model, and the results showed that ICU stay among non-survivors was not significantly different between early and late interventions.

**Table (6):** Meta-analysis for ICU stay (days) among non-survivors.

Study	Effects				Difference		P
	Early		Late		Mean±SE	95%CI	
	N	Mean±SD	N	Mean±SD			
Combes et al.,2015	49	11.0±14.1	44	6.0±8.9	-5.0±2.5	-9.9--0.1	<b>0.044*</b>
Gaudry et al.,2016	150	6.0±8.9	153	6.0±8.1	0.0±1.0	-1.9--1.9	1.000
<b>Overall effect in increasing survival duration</b>					-0.7±0.9	-2.5--1.1	<b>0.459 (z=0.741)</b>
<b>Heterogeneity</b>		<b>I<sup>2</sup></b>		<b>71.628</b>	<b>P</b>		0.060

RR: Relative rate, CI: confidence interval, \*Significant

Funnel plot for ICU stay among non-survivors could not be performed as the included studied were less than three.



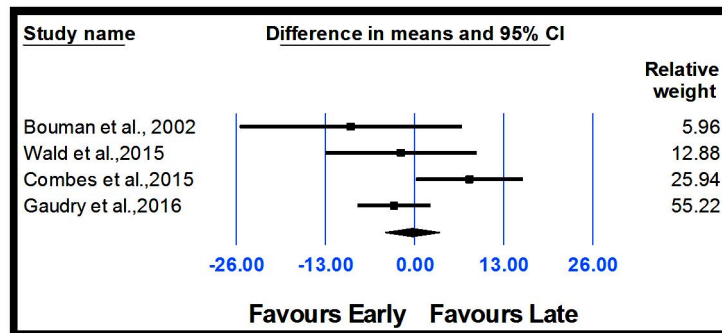
**3- Hospital length of st Survivors**

Table (7) and fig stay among survivors included studies. T

studies. Thus, we a fixed-effects model, hospital stay among different between early

Study							P
Bouman et al., 2002						.9	0.261
Wald et al., 2015						.0	0.722
Combes et al., 2015						3	<b>0.044*</b>
Gaudry et al., 2016						.	0.270
<b>Overall effect</b>							<b>0.846 (z=0.195)</b>
<b>Heterogeneity</b>							084

RR: Relative rate, CI: C



**Figure (6):** Forest plot for hospital stay among survivors

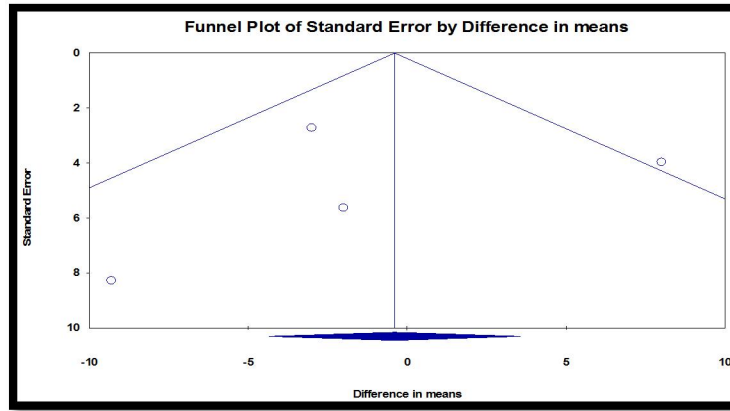
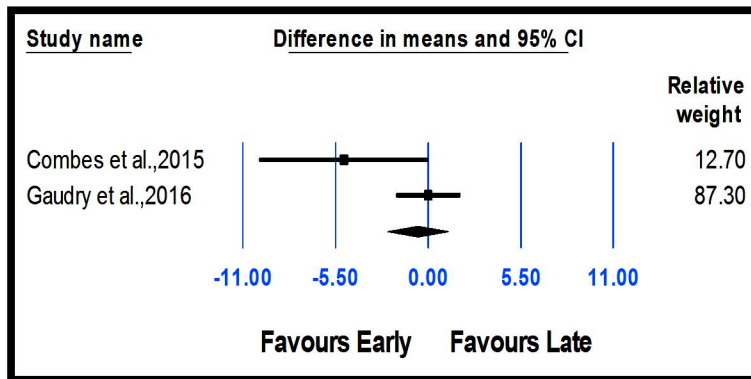


Table (8) and fig among non-survivors studies. There was no these studies. Thus, we

results showed that survivors was not n early and late

Study							P
<b>Combes et al., 2015</b>							0.051
<b>Gaudry et al., 2016</b>							1.000
<b>Overall effect</b>							<b>0.487 (z=0.695)</b>
<b>Heterogeneity</b>							59

RR: Relative rate, CI:



**Figure (8):** Forest plot for hospital stay among non-survivors

Funnel plot for hospital stay among non-survivors could not be performed as the included studied were less than three.

**4-Renal function recovery**

Table (9) and figure (9,10) show that: Renal function recovery was reported in the seven included

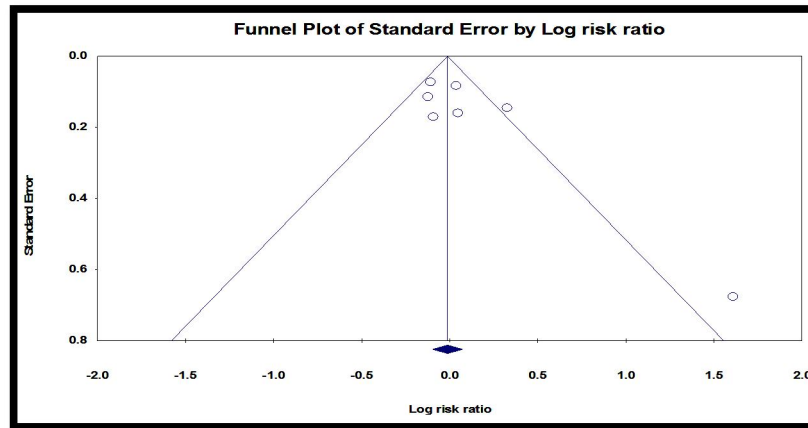
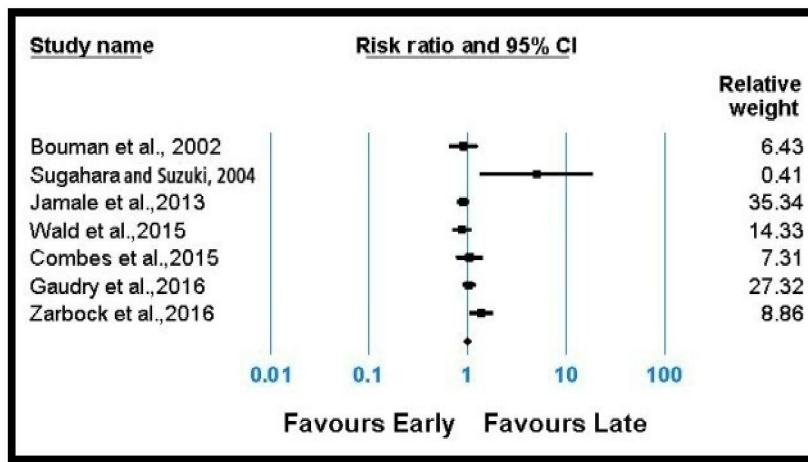
studies. There was significant heterogeneity among these studies. Thus, we performed the statistics using a random-effects model, and the results showed that renal function recovery was not significantly different between early and late interventions.



**Table (9):** Meta-analysis for renal function recovery.

Study	Early (event/total)			Late (event/total)			RR (95% CI)	P
	Total	N	%	Total	N	%		
Bouman et al., 2002	70	39	55.7	36	22	61.1	0.91 (0.65–1.27)	0.587
Sugahara and Suzuki, 2004	14	10	71.4	14	2	14.3	5.00 (1.33–18.81)	<b>0.017*</b>
Jamale et al., 2013	102	76	74.5	106	88	83.0	0.90 (0.78–1.03)	0.137
Wald et al., 2015	112	61	54.5	112	69	61.6	0.88 (0.71–1.11)	0.280
Combes et al., 2015	48	30	62.5	52	31	59.6	1.05 (0.77–1.43)	0.767
Gaudry et al., 2016	311	154	49.5	308	147	47.7	1.04 (0.88–1.22)	0.656
Zarbock et al., 2016	112	60	53.6	119	46	38.7	1.39 (1.04–1.84)	<b>0.025*</b>
<b>Overall effect</b>	--			--			0.99 (0.91–1.07)	0.767 (z=0.297)
<b>Heterogeneity</b>	I <sup>2</sup>			58.878			<b>P</b>	<b>0.024*</b>

RR: Relative rate, CI: Confidence interval, \*Significant



**Figure (10):** Funnel plot for renal function recovery

**5- Renal Replacement Therapy Dependence.**

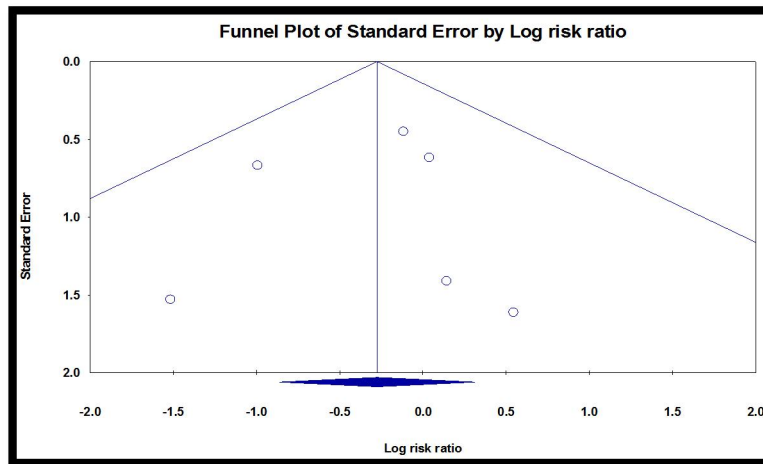
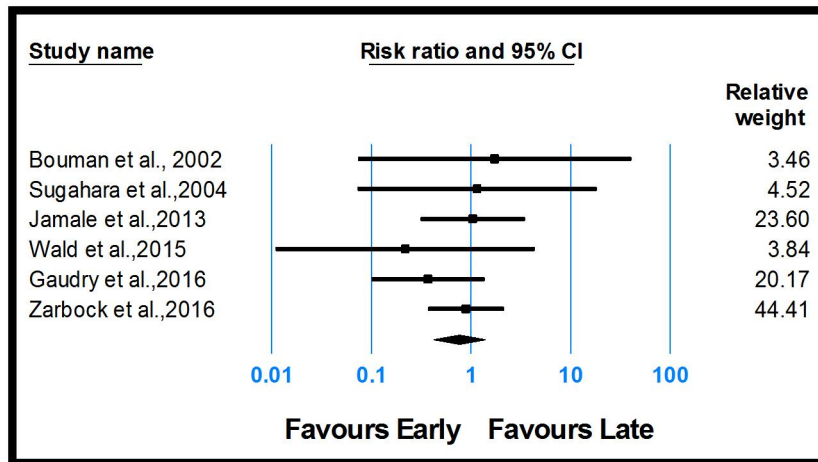
Table (10) and figure (11, 12) show that: Renal replacement therapy dependence was reported in the six included studies. There was no significant heterogeneity among these studies. Thus, we

performed the statistics using a fixed-effects model, and the results showed that renal replacement therapy dependence was not significantly different between early and late interventions.

**Table (10):** Meta-analysis for renal replacement therapy dependence.

Study	early (event/total)			Late (event/total)			RR (95% CI)	P
	Total	N	%	Total	N	%		
Bouman et al., 2002	39	1	2.6	22	0	0.0	1.73 (0.07–40.63)	0.735
Sugahara and suzuki,2004	12	2	16.7	2	0	0.0	1.15 (0.07–18.32)	0.919
Jamale et al., 2013	102	5	4.9	106	5	4.7	1.04 (0.31–3.48)	0.950
Wald et al., 2015	30	0	0.0	33	2	6.1	0.22 (0.01–4.39)	0.321
Gaudry et al., 2016	157	3	1.9	155	8	5.2	0.37 (0.10–1.37)	0.137
Zarbock et al., 2016	67	9	13.4	53	8	15.1	0.89 (0.37–2.15)	0.795
<b>Overall effect</b>	--			--			0.76 (0.42–1.37)	0.357 (z=0.921)
<b>Heterogeneity</b>	I <sup>2</sup>			0.000			P	0.769

RR: Relative rate, CI: Confidence interval, \*Significant



**Figure (12):** Funnel plot for renal replacement therapy dependence

**4. Discussion:**

We enrolled 9 RCTs with a total of 1636 patients in this Meta-analysis and found that “early” RRT had no beneficial effect on mortality of patients with AKI compared with “Late” RRT. Furthermore, pooled analysis of these studies also showed no significant benefit of early RRT in Intensive care unit length of

stay among survivors and non-survivors, hospital length of stay among survivors and non-survivors, renal function recovery and RRT dependence.

It has been known that there are many differences between after-cardiac surgery patients and those with no cardiac surgery, especially on the perioperative hemodynamic management.

However, subgroup analysis of the studies concerning the patients post cardiac surgery or those with non-cardiac surgery did not reveal a survival benefit of early RRT intervention.

In addition, the conclusion remained the same; regardless of whether early was defined by AKI stages according to the KDIGO classification (17) or on the basis of urine output or serum creatinine.

One highlight of this meta-analysis was that we included two new large RCTs (*Gaudry et al., 2016-Zarbock et al., 2016*), which made our results more convincing.

Second, survivors and non-survivors were analyzed separately in the secondary outcome analysis, and the same conclusion was reached.

The most fundamental differences among the trials were the large differences concerning the timing of RRT initiation among studies. Urine output, serum creatinine, serum urea nitrogen and AKI stages were not used unified in the individual studies to define the early and late RRT strategies.

In extreme cases, patients in the early RRT group in one study might be enrolled as late RRT in other studies. The high heterogeneity of definitions of “early” and “late” RRT between RCTs prevented the establishment of definitive conclusions.

Second most studies enrolled AKI patients with a mixed population, whereas the optimal timing of RRT initiation might be associated with the primary diseases.

Moreover, the severity of the primary disease, presence of comorbid conditions, complications after surgery and fluid balance before RRT initiation could also be the possible confounders related to study outcome.

Additionally, we cannot omit the progression of the critical care medicine during the past decade. In the study conducted in patients with acute renal failure following coronary bypass surgery in 2004, the mortality was as high as 86% in the “late” group (*Sugahara et al., 2004*). However, the other study, conducted in post-cardiac surgery shock patients in 2015, showed that the 30-day mortality of the “early” and “late” group was only 36% (*Combes et al., 2015*).

We found that most of the RCTs published over the past decade failed to prove the benefit of early initiation of RRT. Great progress in hemodynamic monitoring, mechanical ventilation, nutrition support and even RRT technology development has been achieved in critical care medicine in the past decade.

Therefore, studies published before 2000 were excluded in this meta-analysis.

Also, The AKIKI study claimed that up to 49% of the patients in the delayed-strategy group avoided receiving RRT (*Gaudry et al., 2016*), The Elian trial gave opposing results (*Zarbock et al., 2016*).

However, we cannot accurately predict the needs for RRT or opportunity of renal recovery in critically ill patients in the retrospective studies.

So we reached this overall conclusion.

## Conclusions

Our meta-analysis revealed that the “early” initiation of RRT in critically ill patients did not result in a reduced Mortality.

A pooled analysis of secondary outcomes Showed no significant difference in Intensive care unit Length of stay (LOS) or hospital Length of stay (LOS) between early and late RRT group for survivors or non- survivors.

A pooled analysis also demonstrated no significant change in renal function recovery and RRT dependence.

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7/24/2019