**Supplemental Digital Content**

Contents

[Search Strategy 2](#_Toc391403527)

[Additional information about data extraction and analysis 16](#_Toc391403528)

[Excluded publications after screening of full text versions and conference abstracts 18](#_Toc391403529)

[Identification of duplicate publications 81](#_Toc391403530)

[Excluded duplicate publications 83](#_Toc391403531)

[Analysis of included publications 85](#_Toc391403532)

[Effectiveness outcomes in the included studies (mixed indication) 88](#_Toc391403533)

[Meta-analysis of effectiveness and safety outcomes 90](#_Toc391403534)

[Table 7. Meta-analysis of effectiveness outcomes, survival (random-effect model) 90](#_Toc391403535)

[Table 8. Meta-analysis of effectiveness outcomes, weaning from support or bridging to repeat heart transplant or VAD (random-effect model) 91](#_Toc391403536)

[Table 10. Meta-analysis of effectiveness outcomes with exclusion of studies, which contribute to heterogeneity (random-effect model) 93](#_Toc391403537)

[Table 11. Meta-analysis of effectiveness outcomes with exclusion of studies, which contribute to heterogeneity (fixed-effect model) 94](#_Toc391403538)

[Table 12. Meta-analysis of adverse events (proportion of patients experienced adverse event) (random-effect model) 95](#_Toc391403539)

[Table 13. Meta-analysis of adverse events (proportion of patients experienced adverse event) (fixed-effect model) 96](#_Toc391403540)

[Technical data. VAD support in pre-cardiotomy cardiogenic shock indication 99](#_Toc391403541)

[Technical data. VAD support in post-cardiac surgery cardiogenic shock indication 103](#_Toc391403542)

[Technical data. VAD support in post-transplant graft rejection or failure indication 106](#_Toc391403543)

[Technical data. Post-LVAD placement right ventricular failure indication 108](#_Toc391403544)

[Technical data. Adverse events 112](#_Toc391403545)

[Technical data. Analysis of adverse events in adult and paediatric populations 119](#_Toc391403546)

[Additional references 127](#_Toc391403547)

[R-code for meta-analysis of effectiveness and safety outcomes 129](#_Toc391403548)

# Search Strategy

The Ovid interface was used for Medline and Medline (R) In-Process, the EMBASE interface for the EMBASE database, and The Cochrane Library interface for the CENTRAL and NHS EED databases. The manufacturer of CentriMag (Thoratec Corporation, Pleasanton, CA, USA) and authors provided information about unpublished studies, if available.

**Study Selection**

The following inclusion criteria were used:

* Population: no restrictions;
* Interventions: magnetically levitated centrifugal pump; CentriMag or PediVAS (manufactured by Levitronix or Thoratec), for extracorporeal membrane oxygenation or ventricular assistance;
* Study design: multiple patient studies including patient registries and audits, case-series studies, cohort studies, observational studies and case-control studies (case studies were accepted for reports of adverse events);
* Language: no restrictions;
* Search dates: from 2003 – present.

Animal and benchtop laboratory studies were excluded. If device name was not stated in the abstract, full text was acquired. As CentriMag entered the market in late 2003, searches were conducted from this date.

During screening of abstracts and evaluation of full text versions, relevance of non-English publications was assessed by native speakers at Synergus AB. To enable review, included non-English publications were professionally translated.

The search strategy for clinical evidence, economic evidence and adverse events in Medline and Medline (R) In-Process databases via OVID, is presented below. The approach recommended in current versions of the Cochrane Handbook for Systematic Reviews of Interventions6 and CRD’s Guidance for Undertaking Reviews in Healthcare64, was used to construct the search strategy. The search strategy consists of a disease and outcomes domain (terms #1-20), a device domain (terms #22-38), an adverse events domain (terms #40-55) and an economics domain (terms #57-71). Boolean operators were used to combine the search terms. Modifications to the medical devices adverse events search filter, recommended by the InterTASC Information Specialists’ Sub-Group, were incorporated into the search strategy64. Search filters for economic evaluations, recommended by the InterTASC Information Specialists’ Sub-Group, were used in the search strategy64. Search strategy was not limited to the brand-name CentriMag, but was designed to identify publications in which ventricular assist devices or ECMO systems were used in patients with acute cardiac or cardiac-pulmonary failure.

**Search strategy in Medline and Medline (R) In-Process databases via OVID**

|  |  |
| --- | --- |
| **#** | **Search terms** |
| 1 | Heart Failure/ or Heart Failure, Diastolic/ or Heart Failure, Systolic/ |
| 2 | exp Myocardial Infarction/ |
| 3 | Respiratory Distress Syndrome, Adult/ |
| 4 | Respiratory Distress Syndrome, Newborn/ |
| 5 | Respiratory Insufficiency/ |
| 5 | cardiogenic shock$.ti,ab. |
| 6 | (respirat$ adj3 (failure$ or insuffi$)).ti,ab. |
| 7 | Hyaline Membrane Disease/ |
| 8 | (respirat$ distress syndrom$ or RDS).ti,ab. |
| 9 | heart transplant$.ti,ab. or heart transplantation/ or exp Lung Transplantation/ or lung transplant$.ti,ab. or heart-lung transplant$.ti,ab. |
| 10 | Myocarditis/ |
| 11 | Cardiomyopathies/ or Cardiomyopathies, Dilated/ |
| 12 | heart failure$.ti,ab. |
| 13 | fulminant myocarditis.ti,ab. |
| 14 | myocardial infarction$.ti,ab. |
| 15 | cardiac failure$.ti,ab. |
| 16 | Hernia, Diaphragmatic/ or congenital diaphragmatic hernia$.ti,ab. |
| 17 | Meconium Aspiration Syndrome/ or meconium aspiration syndrom$.ti,ab. |
| 18 | Persistent Fetal Circulation Syndrome/ or persistent fetal circulation syndrom$.ti,ab. |
| 19 | (cardio-respiratory failure$ or cardiorespiratory failure$):ti,ab |
| 20 | Exp Treatment Outcome/ or treatment outcome$.ti,ab. or Critical Illness/ or critical illness$.ti,ab. |
| 21 | Or/1-20 |
| 22 | Heart, Artificial/ |
| 23 | Assisted Circulation/ |
| 24 | Heart-Lung Machine/ |
| 25 | (centrimag or centri-mag or centri mag or pedivas or pedi vas or pedi-vas or pedimag or pedi-mag or pedi mag or levitronix or thoratec).tw. |
| 26 | Heart-Assist Devices/ |
| 27 | Extracorporeal Membrane Oxygenation/ |
| 28 | ((extracorporeal or extra corporeal or extra-corporeal) adj3 membrane oxygenation).ti,ab. |
| 29 | Cardiopulmonary Bypass/ |
| 30 | Heart Bypass, Left/ or Heart Bypass, Right/ |
| 31 | mechanical circulatory support$.ti,ab. |
| 32 | ((ventricular or biventricular or bi-ventricular) adj3 assist$).ti,ab. |
| 33 | ECMO.ti,ab. |
| 34 | (VAD$ or LVAD$ or L-VAD$ or RVAD$ or R-VAD$ or Bi-VAD$ or BiVAD$).ti,ab. |
| 35 | (cardiac surgical procedures/ or cardiac surgical procedure$.ti,ab.) and (heart failure/ or heart failure$.ti,ab.) |
| 36 | (magnetically and levitated and pump$).tw. |
| 37 | (exp Magnetics/ or magnetic$.ti,ab.) and (22 or 24 or 26 or 27 or 28 or 33 or 34) |
| 38 | (Centrifugation/ or centrifugation$.ti,ab.) and (22 or 24 or 26 or 27 or 28 or 33 or 34) |
| 39 | Or/22-38 |
| 40 | Thrombosis/ or Thromboembolism/ or Embolism/ |
| 41 | thromb$.ti,ab. |
| 42 | Disseminated Intravascular Coagulation/ |
| 43 | (intravascular clotting or blood clotting).ti,ab. |
| 44 | Hemorrhage/ or Blood Loss Surgical/ or Postoperative Hemorrhage/ |
| 45 | (hemorrhage$ or haemorrhage$ or bleed$).ti,ab. |
| 46 | Equipment Failure/ or Product Surveillance, Postmarketing/ or Clinical Trials, Phase IV as Topic/ |
| 47 | ((mechanical or device or equipment) adj3 failure$).tw. |
| 48 | (safe or safety).ti,ab. |
| 49 | side effect$.ti,ab. |
| 50 | ((adverse or undesirable or harm$ or serious) adj3 (effect$ or reaction$ or event$ or outcome$)).ti,ab. |
| 51 | pump failure$.ti,ab. |
| 52 | (cannul$ adj3 (infect$ or bleed$ or hemorrhage$ or haemorrhage$)).ti,ab. |
| 53 | wound infection/ or infection/ or Catheter-Related Infections/ |
| 54 | Hemolysis/ or hemolys$.ti,ab. or haemolys$.ti,ab. |
| 55 | Treatment Outcome/ or treatment outcome$.ti,ab. or Critical Illness/ or critical illness$.ti,ab. |
| 56 | Or/40-55 |
| 57 | economics/ |
| 58 | exp "costs and cost analysis"/ |
| 59 | economics, dental/ |
| 60 | exp "economics, hospital"/ |
| 61 | economics, medical/ |
| 62 | economics, nursing/ |
| 63 | economics, pharmaceutical/ |
| 64 | (economic$ or cost or costs or costly or costing or price or prices or pricing or pharmacoeconomic$).ti,ab. |
| 65 | (expenditure$ not energy).ti,ab. |
| 66 | value for money.ti,ab. |
| 67 | budget$.ti,ab. |
| 68 | Or/57-67 |
| 69 | ((energy or oxygen) adj cost).ti,ab. |
| 70 | (metabolic adj cost).ti,ab. |
| 71 | ((energy or oxygen) adj expenditure).ti,ab. |
| 72 | Or/69-71 |
| 73 | 68 not 72 |
| 74 | letter.pt. |
| 75 | editorial.pt. |
| 76 | historical article.pt. |
| 77 | Or/74-76 |
| 78 | 73 not 77 |
| 79 | Animals/ |
| 80 | Humans/ |
| 81 | 79 not (79 and 80) |
| 82 | 78 not 81 |
| 83 | (21 and 39) or (39 and (46 or 47 or 51)) or (21 and 39 and 56) or (21 and 39 and 82)) or 25 |
| 84 | limit 83 to yr="2003 -Current" |
| 85 | 84 not 81 |

The search strategy for clinical evidence, economic evidence and adverse events in the EMBASE database via the EMBASE interface, is presented below. The approach recommended in current versions of the Cochrane Handbook for Systematic Reviews of Interventions6 and CRD’s Guidance for Undertaking Reviews in Healthcare64, was used to construct the search strategy. The search strategy consists of a disease and outcomes domain (terms #1-15), a device domain (terms #17-35), an adverse events domain (terms #37-51) and economics domain (terms #53-64). Boolean operators were used to combine the search terms. Modifications to the medical devices adverse events search filter, recommended by the InterTASC Information Specialists’ Sub-Group, were incorporated into the search strategy65. Search filters for economic evaluations, recommended by the InterTASC Information Specialists’ Sub-Group, were used in the search strategy65. Search strategy was not limited to the brand-name CentriMag, but was designed to identify publications in which ventricular assist devices or ECMO systems were used in patients with acute cardiac or cardiac-pulmonary failure.

**Search strategy in EMBASE database via EMBASE interface**

|  |  |
| --- | --- |
| # | Search Term |
| 1 | 'heart failure'/de OR 'acute heart failure'/de OR 'cardiogenic shock'/de OR 'cardiopulmonary insufficiency'/de OR 'congestive heart failure'/de OR 'systolic dysfunction'/de |
| 2 | 'heart infarction'/de OR 'acute heart infarction'/de OR 'anterior myocardial infarction'/de OR 'dressler syndrome'/de OR 'heart reinfarction'/de OR 'heart ventricle infarction'/de OR 'inferior myocardial infarction'/de OR 'posterior myocardial infarction'/de OR 'st segment elevation myocardial infarction'/de |
| 3 | 'adult respiratory distress syndrome'/de OR 'neonatal respiratory distress syndrome'/de |
| 4 | 'respiratory failure'/de OR 'acute respiratory failure'/de OR 'cardiopulmonary arrest'/de OR 'cardiopulmonary insufficiency'/de OR 'chronic respiratory failure'/de OR 'lung insufficiency' |
| 5 | 'hyaline membrane disease'/de |
| 5 | 'cardiogenic shock':ab,ti OR 'cardiogenic shocks':ab,ti |
| 6 | (respirat\* NEAR/3 (failure OR insuffi\*)):ab,ti |
| 7 | (respirat\* NEAR/5 ('distress syndrom' OR 'distress syndrome' OR 'distress syndromes')):ab,ti OR rds:ab,ti |
| 8 | 'heart transplantation'/de OR 'lung transplantation'/exp OR ((lung OR heart OR 'heart lung') NEAR/3 transplant\*):ab,ti |
| 9 | 'myocarditis'/de or (dilated NEAR/3 cardiomyopath\*):ab,ti |
| 10 | 'cardiomyopathy'/de OR 'cardiomyopathies, dilated' |
| 11 | 'heart failure':ab,ti OR 'heart failures':ab,ti |
| 12 | 'fulminant myocarditis':ab,ti OR 'myocardial infarction':ab,ti OR 'myocardial infarctions':ab,ti OR 'cardiac failure':ab,ti OR 'cardiac failures':ab,ti |
| 13 | 'hernia, diaphragmatic'/de OR 'congenital diaphragmatic hernia':ab,ti OR 'congenital diaphragmatic hernias':ab,ti |
| 14 | 'meconium aspiration syndrome'/de OR 'meconium aspiration syndrome':ab,ti OR 'meconium aspiration syndromes':ab,ti |
| 15 | 'persistent fetal circulation syndrome'/de OR 'persistent fetal circulation syndrome':ab,ti OR 'persistent fetal circulation syndromes':ab,ti |
| 16 | OR/1-15 |
| 17 | 'artificial heart'/de |
| 18 | 'assisted circulation'/de |
| 19 | 'heart-lung machine'/de |
| 20 | centrimag:ab,ti OR 'centri mag':ab,ti OR 'centri-mag':ab,ti OR levitronix:ab,ti OR pedivas:ab,ti OR 'pedi vas':ab,ti OR 'pedi-vas':ab,ti OR pedimag:ab,ti OR 'pedi mag':ab,ti OR 'pedi-mag':ab,ti OR thoratec:ab,ti |
| 21 | 'heart assist device'/exp |
| 22 | 'extracorporeal oxygenation'/de |
| 23 | ((extracorporeal OR 'extra corporeal' OR 'extra corporeal') NEAR/3 'membrane oxygenation'):ab,ti |
| 24 | 'cardiopulmonary bypass'/de |
| 25 | 'heart left ventricle bypass'/de OR 'cardiopulmonary bypass'/de |
| 26 | 'mechanical circulatory support':ab,ti OR 'mechanical circulatory supports':ab,ti |
| 27 | ((ventricular or biventricular or bi-ventricular) NEAR/3 assist\*):ab,ti |
| 28 | ecmo:ab,ti |
| 29 | vad:ab,ti OR vads:ab,ti OR lvad:ab,ti OR lvads:ab,ti OR 'l vad':ab,ti OR 'l vads':ab,ti OR rvad:ab,ti OR rvads:ab,ti OR 'r vad':ab,ti OR 'r vads':ab,ti OR bivad:ab,ti OR bivads:ab,ti OR 'bi vad':ab,ti OR 'bi vads':ab,ti |
| 30 | 'heart surgery'/de OR 'cardiac surgical procedure':ab,ti OR 'cardiac surgical procedures':ab,ti AND ('heart failure'/de OR 'heart failure':ab,ti OR 'heart failures':ab,ti) |
| 31 | magnetically AND levitated AND pump\* |
| 32 | 'centrifugation'/de OR centrifugation\*:ab,ti |
| 33 | 'magnetism'/exp OR magnet\*:ab,ti |
| 34 | 32 and (17 or 19 or 20 or 22 or 23 or 28 or 29) |
| 35 | 33 and (17 or 19 or 20 or 22 or 23 or 28 or 29) |
| 36 | OR/17-30 OR/35-35 |
| 37 | 'thrombosis'/de OR 'thromboembolism'/de OR 'embolism'/de |
| 38 | thromb\*:ab,ti |
| 39 | 'disseminated intravascular clotting'/de |
| 40 | 'intravascular clotting':ab,ti OR 'blood clotting':ab,ti |
| 41 | 'bleeding'/de |
| 42 | hemorrhage\*:ab,ti OR haemorrhage\*:ab,ti OR bleed\*:ab,ti |
| 43 | 'equipment'/de ‘postmarketing surveillance’/de or ‘phase 4 clinical trial (topic)’/de |
| 44 | ((mechanical OR device OR equipment) NEAR/3 failure\*):ab,ti |
| 45 | safe:ab,ti OR safety:ab,ti |
| 46 | 'side effect':ab,ti OR 'side effects':ab,ti |
| 47 | ((adverse OR undesirable OR harms\* OR serious) NEAR/3 (effect\* OR reaction\* OR event\* OR outcome\*)):ab,ti |
| 48 | 'pump failure':ab,ti OR 'pump failures':ab,ti |
| 49 | (cannul\* NEAR/3 (infect\* OR bleed\* OR hemorrhage\* OR haemorrhage\*)):ab,ti |
| 50 | 'wound infection'/de OR 'infection'/de OR 'catheter infection'/de OR 'treatment outcome'/exp OR 'treatment outcome':ab,ti OR 'treatment outcomes':ab,ti OR 'critical illness'/de OR 'critical illness':ab,ti OR 'critical illnesses':ab,ti |
| 51 | 'hemolysis'/de OR hemolysis\*:ab,ti OR haemolys\*:ab,ti |
| 52 | OR/37-51 |
| 53 | 'health economic' OR 'economic evaluation'/exp OR 'health care cost'/exp OR 'pharmacoeconomics'/exp |
| 54 | econom\*:ab,ti OR cost:ab,ti OR costs:ab,ti OR costly:ab,ti OR costing:ab,ti OR price:ab,ti OR prices:ab,ti OR pricing:ab,ti OR pharmacoeconomic\*:ab,ti |
| 55 | expenditure\*:ab,ti NOT energy:ab,ti OR (value NEAR/2 money):ab,ti OR budget\*:ab,ti |
| 56 | 54 OR 55 |
| 57 | 53 OR 56 |
| 58 | letter:it |
| 59 | editorial:it |
| 60 | note:it |
| 61 | OR/58-60 |
| 62 | (56 OR 57) NOT 61 |
| 63 | (metabolic NEAR/5 cost):ab,ti OR ((energy OR oxygen) NEAR/5 cost):ab,ti OR ((energy OR oxygen) NEAR/5 expenditure):ab,ti |
| 64 | 62 NOT 63 |
| 65 | 'animal'/exp |
| 66 | 'animal experiment'/exp |
| 67 | 'nonhuman'/de |
| 68 | rat:lnk,ab,ti OR rats:lnk,ab,ti OR mouce:lnk,ab,ti OR mice:lnk,ab,ti OR hamster:lnk,ab,ti OR hamsters:lnk,ab,ti OR animal:lnk,ab,ti OR animals:lnk,ab,ti OR dog:lnk,ab,ti OR dogs:lnk,ab,ti OR cat:lnk,ab,ti OR cats:lnk,ab,ti OR bovine:lnk,ab,ti OR sheep:lnk,ab,ti |
| 69 | OR/65-68 |
| 70 | 'human'/exp |
| 71 | 'human experiment'/exp |
| 72 | 70 OR 71 |
| 73 | 69 NOT (69 AND 72) |
| 74 | 64 NOT 73 |
| 75 | (16 AND 36) OR (36 AND (43 OR 44 OR 48)) OR (36 AND 16 AND 74) OR (36 AND 16 AND 52) OR 20 |
| 76 | 75 NOT 73 |
| 77 | 76 AND (2003-2012)/py |
| 78 | 77 AND (embase)/lim NOT (medline)/lim |

The search strategy for clinical evidence, economic evidence and adverse events in the CENTRAL and NHS EED databases via the Cochrane Library interface, is presented below. The approach recommended in current versions of the Cochrane Handbook for Systematic Reviews of Interventions6 and CRD’s Guidance for Undertaking Reviews in Healthcare64, was used to construct the search strategy. The search strategy consists of a disease and outcomes domain (terms #1-27) and a device domain (terms #29-47). Boolean operators were used to combine the search terms. Adverse events and economic search terms were not added to the search strategy to increase its sensitivity.

**Search strategy in CENTRAL and NHS EED databases via Cochrane Library interface**

|  |  |
| --- | --- |
| # | Search Term |
| 1 | [MeSH descriptor Heart Failure, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=1) |
| 2 | [MeSH descriptor Heart Failure, Diastolic, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=2) |
| 3 | [MeSH descriptor Heart Failure, Systolic, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=3) |
| 4 | [MeSH descriptor Myocardial Infarction explode all trees](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=4) |
| 5 | [MeSH descriptor Respiratory Distress Syndrome, Adult, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=5) |
| 5 | [MeSH descriptor Respiratory Insufficiency, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=6) |
| 6 | [(cardiogenic shock\*):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=7) |
| 7 | [(respirat\* NEAR/3 (failure\* or insuffi\*)):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=8) |
| 8 | [MeSH descriptor Hyaline Membrane Disease, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=9) |
| 9 | [(respirat\* distress syndrom\* or RDS):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=10) |
| 10 | [(heart transplant\* or lung transplant\* or heart-lung transplant\*):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=11) |
| 11 | [MeSH descriptor Heart Transplantation, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=12) |
| 12 | [MeSH descriptor Lung Transplantation explode all trees](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=13) |
| 13 | [MeSH descriptor Myocarditis, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=14) |
| 14 | [MeSH descriptor Cardiomyopathies, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=15) |
| 15 | [MeSH descriptor Cardiomyopathy, Dilated, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=16) |
| 16 | [(heart failure\* or fulminant myocarditis or myocardial infarction\* or cardiac failure\*):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=17) |
| 17 | [MeSH descriptor Hernia, Diaphragmatic, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=18) |
| 18 | [(congenital diaphragmatic hernia\*):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=19) |
| 19 | [MeSH descriptor Meconium Aspiration Syndrome, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=20) |
| 20 | [(meconium aspiration syndrom\*):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=21) |
| 21 | [MeSH descriptor Persistent Fetal Circulation Syndrome, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=22) |
| 22 | [(persistent fetal circulation syndrom\*):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=23) |
| 23 | [MeSH descriptor Respiratory Distress Syndrome, Newborn, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=42) |
| 24 | [MeSH descriptor Treatment Outcome explode all trees](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=46) |
| 25 | [MeSH descriptor Critical Illness, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=47) |
| 26 | [(treatment outcome\* OR critical illness\*):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=48) |
| 27 | [(cardio-respiratory failure\* OR cardiorespiratory failure\*):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=49) |
| 28 | OR/1-27 |
| 29 | [MeSH descriptor Heart, Artificial, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=24) |
| 30 | [MeSH descriptor Assisted Circulation, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=25) |
| 31 | [MeSH descriptor Heart-Lung Machine, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=26) |
| 32 | [(centrimag or centri-mag or centri mag or pedivas or pedi-vas or pedi vas or pedimag or pedi-mag or pedi mag or levitronix or thoratec)](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=27) |
| 33 | [MeSH descriptor Extracorporeal Membrane Oxygenation, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=28) |
| 34 | [((extracorporeal or extra corporeal or extra-corporeal) NEAR/3 membrane oxygenation):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=29) |
| 35 | [MeSH descriptor Cardiopulmonary Bypass, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=30) |
| 36 | [MeSH descriptor Heart Bypass, Left, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=31) |
| 37 | [MeSH descriptor Heart Bypass, Right, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=32) |
| 38 | [(mechanical circulatory support\*):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=33) |
| 39 | [(ventricular assist\*):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=34) |
| 40 | [(ECMO):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=35) |
| 41 | [(VAD\* or LVAD\* or L-VAD\* or RVAD\* or R-VAD\* or BiVAD\* or Bi-VAD\*):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=36) |
| 42 | [(magnetically and levitated and pump\*)](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=37) |
| 43 | [MeSH descriptor Heart-Assist Devices, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=43) |
| 44 | [MeSH descriptor Magnetics, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=38) |
| 45 | [(magnetic\*):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=39) |
| 46 | [MeSH descriptor Centrifugation, this term only](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=40) |
| 47 | [(centrifugation\*):ti,ab,kw](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=41) |
| 48 | [(( #44 OR #45 ) AND ( #29 OR #31 OR #33 OR #34 OR #40 OR #41 OR #43))](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=44) |
| 49 | [(( #46 OR #47 ) AND (#29 OR #31 OR #33 OR #34 OR #40 OR #41 OR #43))](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=44) |
| 50 | OR/29-43 OR OR/48-49 |
| 51 | (28 AND 50) OR 32 |
| 52 | 51[, from 2003 to 2012](http://onlinelibrary.wiley.com/o/cochrane/searchHistory?mode=runquery&qnum=53) (NHS EED and ClinicalTrial Database) |

# Additional information about data extraction and analysis

The following data were extracted for this review:

*Study Details:*study acronym, author’s name, intervention, comparator, population; *Methodology:*location, design, duration of study, duration of follow-up, recruitment procedure, intervention and comparator details, primary outcomes, secondary outcomes, inclusion and exclusion criteria; *Patient Characteristics:*age (mean age, standard deviation and range), primary disease and disease which lead to VAD or ECMO support; *Treatment Details:*number of patients who received treatment, number of patients who received treatment with different modes of support, information about switching from one type of support to another (e.g. from ECMO to VAD support, etc.); *Outcomes Measures for:*survival on support, survival at discharge, 30-day, 60-day, 90-day, 6-month and 1-year survival (if available); survival after 1 year, number of patients weaned from support, number of patients bridged to transplant, number of patients bridged to a long-term ventricular assist device, duration of support, length of intensive care unit stay, length of hospital stay, bleeding (including bleeding requiring re-operation or blood transfusion), haemolysis, thrombosis and thromboembolism, neurological complications, renal failure, infections, device failure; *Details of Statistical Analysis:*statistical analysis used, significance level; *Quality Assessment for Observational Studies:*Was the cohort recruited in an acceptable way? Was the exposure accurately measured to minimise bias? Was the outcome accurately measured to minimise bias? Have the authors identified all important confounding factors? Have the authors taken account of the confounding factors in the design and/or analysis? Was the follow-up of patients complete? How precise are the results?

An algorithm for classification of study’s designs, recommended by NICE, was used66. If control group was present in the study, but comparison with CentriMag group was not performed, these studies were classified as case-series studies. Data were extracted as absolute numbers. When absolute numbers were not available, they were calculated from proportions, reported in the study. In the extraction of safety data a zero was extracted only when there was a statement to the effect that a particular event did not occur. No assumptions were made if outcome was not reported and it was not included in analyses.

Survival rates and rate of adverse events were analysed as dichotomous (binary) data. An initial attempt was made to quantify rate of adverse events as continuous data by dividing number of adverse events reported in the group per number of patients in the group. Although as majority of the studies report number of patients, who experienced events, rate of adverse events was analysed as dichotomous outcome.

# Excluded publications after screening of full text versions and conference abstracts

**Table 4. Excluded publications after screening of full text versions and conference abstracts**

| **Study reference** | **Reason for exclusion** |
| --- | --- |
| Agar NJ, Berkowitz RG.Airway complications of pediatric extracorporeal membrane oxygenation.Ann Otol Rhinol Laryngol. 2011 Jun;120(6):353-7 | Device name is not reported |
| Aggarwal S, Stockmann P, Klein MD, Natarajan G.Echocardiographic measures of ventricular function and pulmonary artery size: prognostic markers of congenital diaphragmatic hernia?.J Perinatol. 2011 Aug;31(8):561-6 | Device name is not reported Impact of VAD/ECMO on outcomes is not assessed |
| Ahmad T, Mentz RJ, Felker GM, Milano CA, Rogers JG, Patel CB.Recurrence of heart failure symptoms after LVAD placement due to bradycardia-induced inflow obstruction.J Heart Lung Transplant. 2012 Jan;31(1):111-3 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec. Case study |
| Aigner C, Wisser W, Taghavi S, Lang G, Jaksch P, Czyzewski D, Klepetko W.Institutional experience with extracorporeal membrane oxygenation in lung transplantation.Eur J Cardiothorac Surg. 2007 Mar;31(3):468-73 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Al-Hertani W, Kantor PF, Halliday W, Robinson BH, Siriwardena K. Case report: Variable histochemical findings in two siblings with sengers syndrome. J Inherit. Metab. Dis. 2011;34(S3):S162 | Not relevant to research questions |
| Alsara OO, Terzic CM, Park SJ, Squires RW, Thomas RJ. Cardiac rehabilitation in patients receiving LVAD therapy: The Mayo Clinic experience. J Cardiopulm Rehabil Prev. 2011;31(4):E9 | Device name is not reported. |
| Alshehri SS, Shetty R, Caldarone CA, Gruenwald C, Manlhiot C, McCrindle BW, Schwartz SM, Van Arsdell GS, Sivarajan VB. Neurological and cardiac functional status after extracorporeal membrane oxygenation in children with heart disease. Circulation 2011;124(21) | Device name is not reported |
| Anastasiadis K, Papaconstantinou C. Mechanical support of patients with dilated cardiomyopathy. Epitheorese Klin Farmakol Farmakokinet. 2010;28(2):197-202 | Review |
| Anastasiadis K, Antonitsis P, Chalvatzoulis O, Papakonstantinou C. Use of a novel short-term mechanical circulatory support device for cardiac recovery. J Heart Lung Transplant. 2011 Jun;30(6):732-3 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Anderson E, Jaroszewski D, Pierce C, DeValeria P, Arabia F. Parallel application of extracorporeal membrane oxygenation and the Cardiowest total artificial heart as a bridge to transplant. Ann Thorac Surg. 2009 Nov;88(5):1676-8 | Case report of CentriMag (assessment of clinical effectiveness) |
| Askegard-Giesmann JR, Besner GE, Fabia R, Caniano DA, Preston T, Kenney BD. Extracorporeal membrane oxygenation as a lifesaving modality in the treatment of pediatric patients with burns and respiratory failure. J Pediatr Surg. 2010 Jun;45(6):1330-5 | Device name is not reported |
| Aubert S, Leprince P, Bonnet N, Barreda T, Ouattara A, Varnous S, Pavie A, Gandjbakhch I. Limited mechanical circulatory support following orthotopic heart transplantation. Interact Cardiovasc Thorac Surg. 2006 Apr;5(2):88-9 | Device name is not reported |
| [Backer CL. Re: Outcome of extracorporeal membrane oxygenation for early primary graft failure after pediatric heart transplantation. J Am Coll Cardiol. 2009 Aug 18;54(8):738-9](http://www.ncbi.nlm.nih.gov.proxy.kib.ki.se/pubmed?term=%22Backer%20CL%22%5BAuthor%5D) | Editorial |
| Bakhtiary F, Keller H, Dogan S, Dzemali O, Oezaslan F, Meininger D, Ackermann H, Zwissler B, Kleine P, Moritz A. Venoarterial extracorporeal membrane oxygenation for treatment of cardiogenic shock: clinical experiences in 45 adult patients. J Thorac Cardiovasc Surg. 2008 Feb;135(2):382-8 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Balasubramanian SK, Tiruvoipati R, Amin M, Aabideen KK, Peek GJ, Sosnowski AW, Firmin RK. Factors influencing the outcome of paediatric cardiac surgical patients during extracorporeal circulatory support. J Cardiothorac Surg. 2007 Jan 11;2:4 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Barbanti C, Vedovati S, Pellicioli I, Bonanomi E, Corno M, Lucianetti A, Codazzi D. Veno-venous extracorporeal membrane oxygenation in a pediatric nonintubated patient as a bridge to redo lung transplantation.Intensive Care Med. 2011; 37(S2):S418-S419 | Device name is not reported. Case study |
| Barge-Caballero E, Paniagua-Martin MJ, Marzoa-Rivas R, Campo-Perez R, Rodriguez-Fernandez JA, Perez-Perez A, Garcia-Bueno L, Blanco-Canosa P, Cancela ZG, Solla-Buceta M, Juffe-Stein A, Herrera-Norena JM, Cuenca-Castillo JJ, Muniz J, Castro-Beiras A, Crespo-Leiro MG. Usefulness of the INTERMACS Scale for predicting outcomes after urgent heart transplantation. Rev Esp Cardiol. 2011 Mar;64(3):193-200 | Device name is not reported |
| Barnewolt CE, Kunisaki SM, Fauza DO, Nemes LP, Estroff JA, Jennings RW. Percent predicted lung volumes as measured on fetal magnetic resonance imaging: a useful biometric parameter for risk stratification in congenital diaphragmatic hernia. J Pediatr Surg. 2007 Jan;42(1):193-7 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec. Impact of VAD/ECMO on outcomes is not assessed |
| BarZiv SM, McCrindle BW, West LJ, Edgell D, Coles JG, VanArsdell GS, Bohn D, Perez R, Campbell A, Dipchand AI. Outcomes of pediatric patients bridged to heart transplantation from extracorporeal membrane oxygenation support.ASAIO J 2007 Jan-Feb;53(1):97-102 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Bastero P, Goldsworthy M, Best D, Butt W, Shekerdemian L. Ecmo comes of age: 21 year of extracorporeal membrane oxygenation for respiratory failure beyond the neonatal period at the royal children's hospital, Melbourne. Pediatr Crit Care Med. 2011;12(3):A59-A60 | Device name is not reported |
| Busch T, Laudi S, Kaisers U. Ventilatory support versus ECMO for severe adult respiratory failure. Lancet 2010 Feb 13;375(9714):549 | Letter |
| Bedossa M, Flecher E, Guillaume L, Bertheuil N, Fouquet O, Bellouin A, Verhoye JP.  Acute myocardial infarction and refractory shock: Is there a way with ECMO? Analysis of the results of a French center. Catheterization and Cardiovascular Interventions 2010; 75 Suppl. 2 (S62-S63) | Device name is not reported |
| Beiderlinden M, Eikermann M, Boes T, Breitfeld C, Peters J. Treatment of severe acute respiratory distress syndrome: role of extracorporeal gas exchange. Intensive Care Med. 2006 Oct;32(10):1627-31 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Bein T, Graf B, Weber-Carstens S. Ventilatory support versus ECMO for severe adult respiratory failure. Lancet 2010 Feb 13;375(9714):549-50 | Letter |
| Beitzke D, Wieselthaler G, Schima H, Loewe C. Pulmonary embolism in a patient with a biventricular assist device--imaging with multislice computed tomography. Eur J Cardiothorac Surg. 2011 Mar;39(3):415 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Belle L, Mangin L, Bonnet H, Fol S, Santre C, Bougon D, Vialle E, Dompnier A, Desjoyaux E, Blin D. Emergency extra-corporeal membrane oxygenation in cardiac shock and cardiac arrest in hospital without on-site cardiac surgical facilities. Eur. Heart J. 2011;32(S1):80-81 | Device name is not reported |
| Belohlavek J, Rohn V, Kunstyr J, Lips M, Semrad M, Horak J, Mlejnsky F, Tosovsky J, Linhart A, Lindner J. Extracorporeal membrane oxygenation in acute cardiology. Eur Heart J Suppl. 2010;12:F93 | Device name is not reported |
| Belohlávek J, Rohn V, Tosovsky J, Kunstyr J, Semrád M, Horák J, Lips M, Mlejnsky F, Vykydal I, Balík M, Strítesky M, Mrázek V, Klein A, Linhart A, Lindner J. A review of a newly established ECMO program in a university affiliated cardiac center. J Cardiovasc Surg (Torino). 2011 Jun;52(3):445-51 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Belohlavek J, Rohn V, Jansa P, Tosovsky J, Kunstyr J, Semrad M, Horak J, Lips M, Mlejnsky F, Balik M, Klein A, Linhart A, Lindner J. Veno-arterial ECMO in severe acute right ventricular failure with pulmonary obstructive hemodynamic pattern. J Invasive Cardiol. 2010 Aug;22(8):365-9 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Bembea MM, Savage W, Strouse JJ, Schwartz JM, Graham E, Thompson CB, Everett A. Glial fibrillary acidic protein as a brain injury biomarker in children undergoing extracorporeal membrane oxygenation. Pediatr Crit Care Med. 2011 Sep;12(5):572-9 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Ben Gal T, Iakobishvili Z, Abuhazira M, Yaari V, Hasdai D, Battler A, Porath E, Medalion B. Axial flow pump left ventricular assist device (LVAD) as destination therapy:a single center experience. European Journal of Heart Failure 2010; 9 Suppl. 1 (S277-S278) | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec. |
| Bermudez C, Toyoda Y, Avila F, Mulukutla S, Marroquin O, Teuteberg J, Kormos R. Use of extracorporeal membrane oxygenation ( ECMO) in patients with chronic cardiomyopathy: A word of caution. Journal of Heart and Lung Transplantation 2010; 29:2 Suppl. 1 (S179-S180) | Device name is not reported |
| Bermudez CA, Rocha RV, Toyoda Y, Zaldonis D, Sappington PL, Mulukutla S, Marroquin OC, Toma C, Bhama JK, Kormos RL. Extracorporeal membrane oxygenation for advanced refractory shock in acute and chronic cardiomyopathy. Ann Thorac Surg. 2011 Dec;92(6):2125-31 | Device name is not reported |
| Bermudez CA, Abarca A, Zaldonis D, Toyoda Y, Bhama JK, Bonde P, Teuteberg JJ, McNamara D, Alvarez RJ, Kormos R. Midterm outcomes of patients undergoing durable VAD support for acute myocardial infarction complicated with cardiogenic shock. J Heart Lung Transplant 2011;30(4):S216 | Device name is not reported |
| Bermudez CA, Rocha RV, Zaldonis D, Bhama JK, Crespo MM, Shigemura N, Pilewski JM, Sappington PL, Boujoukos AJ, Toyoda Y. Extracorporeal membrane oxygenation as a bridge to lung transplant: midterm outcomes. Ann Thorac Surg. 2011 Oct;92(4):1226-31 | Outcomes are not reported separately for CentriMag, BP-80 pump and Rota Flow Jostra pump |
| Bibro C, Lasich C, Rickman F Jr, Foley NE, Kunugiyama SK, Moore E, O'Brien A, Sherman N, Schulman CS. Critically ill patients with H1N1 influenza A undergoing extracorporeal membrane oxygenation. Crit Care Nurse. 2011 Oct;31(5):e8-e24 | Device name is not reported. Case study |
| Bilen O, Loftis L, Teruya J. Severe thrombotic and bleeding complications in a baby with heterozygous factor V Leiden and acquired von Willebrand disease on ECMO. J Extra Corpor Technol. 2011 Jun;43(2):64-9 | Device name is not reported |
| Birks EJ, Tansley PD, Hardy J, George RS, Bowles CT, Burke M, Banner NR, Khaghani A, Yacoub MH. Left ventricular assist device and drug therapy for the reversal of heart failure. N Engl J Med. 2006 Nov 2;355(18):1873-84 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Bittner HB, Binner C, Lehmann S, Kuntze T, Rastan A, Mohr FW. Replacing cardiopulmonary bypass with extracorporeal membrane oxygenation in lung transplantation operations. Eur J Cardiothorac Surg. 2007 Mar;31(3):462-7 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Bonacchi M, Harmelin G, Peris A, Sani G. A novel strategy to improve systemic oxygenation in venovenous extracorporeal membrane oxygenation: the "χ-configuration". J Thorac Cardiovasc Surg. 2011 Nov;142(5):1197-204 | Device name is not reported. |
| Bostic RR. Heart transplant and left ventricular assist device costs. J Heart Lung Transplant 2005 Nov;24(11):1997-8 | Letter |
| Boyle AJ, Savitt MA, Sulemanjee NZ, Hastings TE, Crouch JD, Warren GV, Wallach JD, Nagendran K, Anigbogu ME, Downey FX. Mechanical circulatory support in dialysis patients. J Heart Lung Transplant 2011;30(4):S213-S214 | Device name is not reported |
| Brenyo A, Rao M, Koneru S, Hallinan W, Shah S, Massey HT, Chen L, Polonsky B, McNitt S, Huang DT, Goldenberg I, Aktas M. Risk of Mortality for Ventricular Arrhythmia in Ambulatory LVAD Patients. J Cardiovasc Electrophysiol. 2011 Nov 14. doi: 10.1111/j.1540-8167 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Brewer RJ, Morgan JA, Nemeh H, Williams C, Czerska B, Tita C, Drost C, Smith C, Chernich J, Lanfear D. Persistent right ventricular failure after LVAD implantation for bridge-to-transplant does not reduce survival to transplantation. J Card Fail. 2009;15(6)(S1):S47 | Device name is not reported |
| Brindley PG, Cave D, Lequier L. Extracorporeal membrane oxygenation (ECMO) in severe adult respiratory distress syndrome. Canadian Journal of Anesthesia 2010; 57:3 (273-275) | Review |
| Brogan TV, Thiagarajan RR, Rycus PT, Bartlett RH, Bratton SL. Extracorporeal membrane oxygenation in adults with severe respiratory failure: a multi-center database. Intensive Care Med. 2009 Dec;35(12):2105-14 | Device name is not reported |
| Brothers M, Kreeger J, Mahle WT. Examination of hyperlucent foci and clinical outcomes in pediatric cardiac patients on extracorporeal membrane oxygenation. Echocardiography. 2011 Mar;28(3):358-62 | Device name is not reported |
| Brown KL, Wray J, Wood TL, Mc Mahon AM, Burch M, Cairns J. Cost utility evaluation of extracorporeal membrane oxygenation as a bridge to transplant for children with end-stage heart failure due to dilated cardiomyopathy. J Heart Lung Transplant. 2009 Jan;28(1):32-8 | Device name is not reported |
| Brown KL, Walker G, Grant DJ, Tanner K, Ridout DA, Shekerdemian LS, Smith JH, Davis C, Firmin RK, Goldman AP. Predicting outcome in ex-premature infants supported with extracorporeal membrane oxygenation for acute hypoxic respiratory failure. Arch Dis Child Fetal Neonatal Ed. 2004 Sep;89(5):F423-7 | Device name is not reported |
| Bruckner BA, DiBardino DJ, Ning Q, Adeboygeun A, Mahmoud K, Valdes J, Eze J, Allison PM, Cooley DA, Gregoric ID, Frazier OH. High incidence of thromboembolic events in left ventricular assist device patients treated with recombinant activated factor VII. J Heart Lung Transplant 2009 Aug;28(8):785-90 | Outcomes are not reported separately for CentriMag |
| Brunet D, Eltchaninoff H, Kerkeni M, Tron C, Baala B, Litzler PY, Bessou JP, Cribier A. Mechanical circulatory assistance in myocardial infarction with refractory cardiogenic shock: clinical experience in 10 patients at a teaching hospital in Rouen. Arch Cardiovasc Dis. 2008 Jan;101(1):30-4 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Bryner BS, Kim AC, Khouri JS, Drongowski RA, Bruch SW, Hirschl RB, Mychaliska GB. Right-sided congenital diaphragmatic hernia: high utilization of extracorporeal membrane oxygenation and high survival. J Pediatr Surg. 2009 May;44(5):883-7 | Device name is not reported |
| Cabrera AG, Prodhan P, Cleves MA, Fiser RT, Schmitz M, Fontenot E, McKamie W, Chipman C, Jaquiss RD, Imamura M.Interhospital transport of children requiring extracorporeal membrane oxygenation support for cardiac dysfunction. Congenit Heart Dis. 2011 May-Jun;6(3):202-8 | Device name is not reported |
| Camboni D, Philipp A, Lubnow M, Bein T, Haneya A, Diez C, Schmid C, Müller T. Support time-dependent outcome analysis for veno-venous extracorporeal membrane oxygenation. Eur J Cardiothorac Surg. 2011 Dec;40(6):1341-6;discussion 1346-7 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Camboni D, Philipp A, Foltan M, Ruprecht L, Müller T, Lubnow M, Arlt M, Hilker M, Schmid C. Institutional experience with veno-venous extracorporeal membrane oxygenation in 89 adult patients suffering from acute lung failure. Thoracic and Cardiovascular Surgeon 2011; 58 Suppl. 1 | Device name is not reported |
| Cardarelli MG, Young AJ, Griffith B. Use of extracorporeal membrane oxygenation for adults in cardiac arrest (E-CPR): a meta-analysis of observational studies. ASAIO J 2009 Nov-Dec;55(6):581-6 | Device name is not reported. Systematic review |
| Casida JM, Parker J. A preliminary investigation of symptom pattern and prevalence before and up to 6 months after implantation of a left ventricular assist device. J Artif Organs. 2011 Nov 26 | Device name is not reported |
| Chan KK, Lee KL, Lam PK, Law KI, Joynt GM, Yan WW.Hong Kong's experience on the use of extracorporeal membrane oxygenation for the treatment of influenza A (H1N1). Hong Kong Med J. 2010 Dec;16(6):447-54 | Device name is not reported |
| Chen YS, Yu HY, Huang SC, Chiu KM, Lin TY, Lai LP, Lin FY, Wang SS, Chu SH, Ko WJ. Experience and result of extracorporeal membrane oxygenation in treating fulminant myocarditis with shock: what mechanical support should be considered first?. J Heart Lung Transplant 2005 Jan;24(1):81-7 | Device name is not reported |
| Chenaitia H, Massa H, Toesca R, Michelet P, Auffray JP, Gariboldi V. Mobile cardio-respiratory support in prehospital emergency medicine. Eur J Emerg Med. 2011 Apr;18(2):99-101 | Device name is not reported |
| Cheng RK, Tseng CH, Shemin R, MacLellan WR. Prognostic scoring in patients requiring BIVAD as a bridge to cardiac transplantation.J. Card. Fail. 2011;17(8);S1:S83-S84 | Device name is not reported |
| Chestovich PJ, Kwon MH, Cryer HG, Tillou A, Hiatt JR. Surgical procedures for patients receiving mechanical cardiac support. Am Surg. 2011 Oct;77(10):1314-7 | Device name is not reported |
| Chou NK, Chi NH, Wu IW, Huang SC, Chen YS, Yu HY, Tsao CI, Ko WJ, Chu SH, Wang SS. Extracoporeal membrane oxygenation hybrid with Thoratec ventricular-assist devices as double bridge to heart transplantation. Transplant Proc. 2010 Apr;42(3):920-2 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Chou NK, Chi NH, Ko WJ, Yu HY, Huang SC, Wang SS, Lin FY, Chu SH, Chen YS. Extracorporeal membrane oxygenation for perioperative cardiac allograft failure ASAIO J 2006 Jan-Feb;52(1):100-3 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Chung JC, Tsai PR, Chou NK, Chi NH, Wang SS, Ko WJ. Extracorporeal membrane oxygenation bridge to adult heart transplantation.Clin Transplant 2010 May-Jun;24(3):375-80. | Device name is not reported. |
| Chung SY, Chua S, Tsai TH, Chen YL, Yip HK. Outcome of profound cardiogenic shock patients undergoing cardiopulmonary resuscitation and quickly extracorporeal membrane oxygenation support: A single-center of clinical observational study. Eur Heart J.2011;32(S1):1047 | Device name is not reported |
| Cianchi G, Bonizzoli M, Pasquini A, Bonacchi M, Zagli G, Ciapetti M, Sani G, Batacchi S, Biondi S, Bernardo P, Lazzeri C, Giovannini V, Azzi A, Abbate R, Gensini G, Peris A. Ventilatory and ECMO treatment of H1N1-induced severe respiratory failure: results of an Italian referral ECMO center. BMC Pulm Med. 2011 Jan 11;11:2 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Ciapetti M, Cianchi G, Zagli G, Greco C, Pasquini A, Spina R, Batacchi S, Bonizzoli M, Bonacchi M, Lazzeri C, Bernardo P, Peris A. Feasibility of inter-hospital transportation using extra-corporeal membrane oxygenation (ECMO) support of patients affected by severe swine-flu(H1N1)-related ARDS.Scand J Trauma Resusc Emerg Med. 2011 May 27;19:32 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Cleveland JC Jr, Naftel DC, Reece TB, Murray M, Antaki J, Pagani FD, Kirklin JK. Survival after biventricular assist device implantation: an analysis of the Interagency Registry for Mechanically Assisted Circulatory Support database.J Heart Lung Transplant 2011 Aug;30(8):862-9 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Cohn WE, Gregoric ID, La Francesca S, Frazier OH. Bedside right ventricular assist device removal in the conscious patient.  Ann Thorac Surg 2007; 83:1556-1557 | Case report of CentriMag (assessment of clinical effectiveness) |
| Cordell-Smith JA, Roberts N, Peek GJ, Firmin RK.Traumatic lung injury treated by extracorporeal membrane oxygenation (ECMO).Injury. 2006 Jan;37(1):29-32 | Device name is not reported |
| Cortina G, Jungraithmayr T, Schönlaub J, Schermer E, Neu N, Frühwirth M, Zimmerhackl LB.  Extracorporeal membrane oxygenation (ECMO) with or without renal replacement therapy (RRT) in a pediatric intensive care unit. Pediatric Nephrology 2010 25:8 (1589) | Device name is not reported |
| Cortina G, Schonlaub J, Geiger R, Schweigmann U, Schermer E, Neu N, Fruhwith M. Extracorporal membrane oxygenation ( ECMO) with or without renal replacment therapy ( RRT) in a pediatric intensive care unit. Pediatr Crit Care Med.2011;12(3):A71 | Device name is not reported |
| D'Alessandro C, Golmard JL, Barreda E, Laali M, Makris R, Luyt CE, Leprince P, Pavie A. Predictive risk factors for primary graft failure requiring temporary extra-corporeal membrane oxygenation support after cardiac transplantation in adults. Eur J Cardiothorac Surg. 2011 Oct;40(4):962-9 | Device name is not reported |
| D'Alessandro C, Aubert S, Golmard JL, Praschker BL, Luyt CE, Pavie A, Gandjbakhch I, Leprince P. Extra-corporeal membrane oxygenation temporary support for early graft failure after cardiac transplantation. Eur J Cardiothorac Surg. 2010 Feb;37(2):343-9 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Daly A, Sobajima H, Olia S, Takatani S, Kameneva M. Application of drag-reducing polymer solutions as test fluids for *in vitro* evaluation of potential blood damage in blood pumps. ASAIO J 2010 Jan-Feb;56(1):6-11 | Technical study of CentriMag pump |
| D'Ancona G, Capitanio G, Chiaramonte G, Serretta R, Turrisi M, Pilato M, Arcadipane A. Extracorporeal membrane oxygenator rescue and airborne transportation of patients with influenza A (H1N1) acute respiratory distress syndrome in a Mediterranean underserved area. Interact Cardiovasc Thorac Surg. 2011 Jun;12(6):935-7 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Dasse K, Gellman B, Kameneva M, Wooley J, Johnson C, Gempp T, Marks J, Kent S, Koert A, Richardson S, Franklin S, Snyder T, Wearden P, Wagner W, Gilbert R, Borovetz H. Assessment of hydraulic performance and biocompatibility of a maglev centrifugal pump system designed for pediatric cardiac or cardiopulmonary support. ASAIO J 2007;52:771-777 | Technical study of CentriMag pump |
| Dassinger MS, Copeland DR, Gossett J, Little DC, Jackson RJ, Smith SD. Congenital Diaphragmatic Hernia Study Group. Early repair of congenital diaphragmatic hernia on extracorporeal membrane oxygenation. J Pediatr Surg. 2010 Apr;45(4):693-7 | Device name is not reported |
| Davies RR, Russo MJ, Yang J, Quaegebeur JM, Mosca RS, Chen JM. Listing and transplanting adults with congenital heart disease. Circulation. 2011 Feb 22;123(7):759-67 | Device name is not reported |
| Davies RR, Russo MJ, Hong KN, O'Byrne ML, Cork DP, Moskowitz AJ, Gelijns AC, Mital S, Mosca RS, Chen JM. The use of mechanical circulatory support as a bridge to transplantation in pediatric patients: an analysis of the United Network for Organ Sharing database. J Thorac Cardiovasc Surg. 2008 Feb;135(2):421-7 | Device name is not reported |
| Davis MK, Higgins J, Kaan A, Ignaszewski A, Cheung A. Outcomes of patients with acute right ventricular failure in the era of mechanical circulatory support. J. Card. Fail. 2011;17(8):S46 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Deckert Z, Stoiber M, Reindl C, Germann P, Wieselthaler G, Schima H. Compact ECMO System with a Magnetically Levitated Blood Pump. ISRBP Tokyo 2005 Sep. (Abstract) | No clinical outcomes are reported for patients receiving support with CentriMag |
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| Sharples LD, Dyer M, Cafferty F, Demiris N, Freeman C, Banner NR, Large SR, Tsui S, Caine N, Buxton M. Cost-effectiveness of ventricular assist device use in the United Kingdom: results from the evaluation of ventricular assist device programme in the UK (EVAD-UK). J Heart Lung Transplant. 2006 Nov;25(11):1336-43 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
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| Syburra T, Lachat M, Genoni M, Wilhelm MJ. Fatal outcome of recombinant factor VIIa in heart transplantation with extracorporeal membrane oxygenation. Ann Thorac Surg. 2010 May;89(5):1643-5 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec. Case study |
| Taghavi S, Zuckermann A, Ankersmit J, Wieselthaler G, Rajek A, Laufer G, Wolner E, Grimm M. Extracorporeal membrane oxygenation is superior to right ventricular assist device for acute right ventricular failure after heart transplantation. Ann Thorac Surg. 2004 Nov;78(5):1644-9 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Takayama H, Naka Y, Jorde UP, Stewart AS. Less invasive left ventricular assist device placement for difficult resternotomy. J Thorac Cardiovasc Surg. 2010 Oct;140(4):932-3. Epub 2010 Jun 11 | Case report of CentriMag (assessment of clinical effectiveness) |
| Tanawuttiwat T, Trachtenberg BH, Hershberger RE, Hare JM, Cohen MG. Dual percutaneous mechanical circulatory support as a bridge to recovery in fulminant myocarditis. ASAIO J 2011 Sep-Oct;57(5):477-9 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec. Case report |
| Tarzia V, Gasparetto N, Cacciavillani L, Bottio T, Bianco R, Marra MP, Hiso E, Marzari A, Iliceto S, Gerosa G. Extracorporeal membrane oxygenation as a bridge to life for refractory cardiogenic shock. Circulation. 2011;124(21);S1 | Device name is not reported |
| Taskin ME, Fraser KH, Zhang T, Gellman B, Fleischli A, Dasse KA, Griffith BP, Wu ZJ. Computational Characterization of Flow and Hemolytic Performance of the UltraMag Blood Pump for Circulatory Support. Artif Organs. 2010 Dec;34(12):1099-113. doi: 10.1111/j.1525-1594.2010.01017.x | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec. Technical study |
| Tayama E, Aoyagi S. Timing of conversion from percutaneous cardiopulmonary support system to left ventricular assist system for severe fulminant myocarditis. Ann Thorac Cardiovasc Surg. 2010 Aug;16(4):301-2 | Device name is not reported |
| Tedford RJ, James C, Judge DP, Tichnell C, Murray B, Bhonsale A, Philips B, Abraham T, Dalal D, Halushka MK, Tandri H, Calkins H, Russell SD. Cardiac transplantation in arrhythmogenic right ventricular dysplasia/cardiomyopathy. J Am Coll Cardiol. 2012 Jan 17;59(3):289-90 | Device name is not reported |
| Teele SA, Allan CK, Laussen PC, Newburger JW, Gauvreau K, Thiagarajan RR. Management and outcomes in pediatric patients presenting with acute fulminant myocarditis. J Pediatr. 2011 Apr;158(4):638-643.e1 | Device name is not reported |
| Thiagarajan RR, Laussen PC, Rycus PT, Bartlett RH, Bratton SL. Extracorporeal membrane oxygenation to aid cardiopulmonary resuscitation in infants and children. Circulation. 2007 Oct 9;116(15):1693-700 | Device name is not reported |
| Thompson JT, Molnar JA, Hines MH, Chang MC, Pranikoff T. Successful management of adult smoke inhalation with extracorporeal membrane oxygenation. J Burn Care Rehabil. 2005 Jan-Feb;26(1):62-6 | Device name is not reported |
| Thourani VH, Kirshbom PM, Kanter KR, Simsic J, Kogon BE, Wagoner S, Dykes F, Fortenberry J, Forbess JM. Venoarterial extracorporeal membrane oxygenation (VA-ECMO) in pediatric cardiac support. Ann Thorac Surg. 2006 Jul;82(1):138-44 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Timpa JG, O'Meara C, McILwain RB, Dabal RJ, Alten JA. Massive systemic air embolism during extracorporeal membrane oxygenation support of a neonate with acute respiratory distress syndrome after cardiac surgery. J Extra Corpor Technol. 2011 Jun;43(2):86-8 | Case report |
| Toda K, Fujita T, Shimahara Y, Sato S, Kobayashi J, Seguchi O, Murata Y, Yanase M, Nakatani T. Role of percutaneous veno-arterial extracorporeal membrane oxygenation as a bridge to long-term left ventricular assist device. Circulation.2011;124(21) | Device name is not reported |
| Topkara VK, Dang NC, Barili F, Martens TP, George I, Cheema FH, Bardakci H, Ozcan AV, Naka Y. Ventricular assist device use for the treatment of acute viral myocarditis. J Thorac Cardiovasc Surg. 2006 May;131(5):1190-1 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Toyoda Y, Bhama J, Shigemura N, Bonde P, Bansal A, Crespo M, Pilewski J, Bermudez C. Veno-venous extracorporeal membrane oxygenation works for primary graft failure in lung transplantation-a large single center experience. Chest. 2011;140(4):1022A.doi: 10.1378/chest.1118126 | Device name is not reported |
| Travis AR, Giridharan GA, Pantalos GM, Dowling RD, Prabhu SD, Slaughter MS, Sobieski M, Undar A, Farrar DJ, Koenig SC. Vascular pulsatility in patients with a pulsatile- or continuous-flow ventricular assist device. J Thorac Cardiovasc Surg. 2007 Feb;133(2):517-24 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Tsai T, Yu J, Wu Y, Wang Y. Extracorporeal life support in multitrauma patients with severe brain injury and acute respiratory distress syndrome. Chest.2011;140(4):198A.doi: 10.1378/chest.1113950 | Device name is not reported |
| Tseng YH, Wu MY, Tsai FC, Chen HJ, Lin PJ. Costs associated with extracorporeal life support used in adults: A single-center study. Acta Cardiol. Sin. 2011;27(4):221-228.NA | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Tuzun E, Akay M, Karabay K, Tamez D, Frazier H, Kadipasoglu K. Hematological, biochemical and end organ effects of the Levitronix centrifugal left ventricular assist device in a bovine model. Turk Gogus Kalp Damar Cerrahisi Dergisi 2005;13(3):199-204 | Animal study of CentriMag |
| Turner DA, Rehder KJ, Peterson-Carmichael SL, Ozment CP, Al-Hegelan MS, Williford WL, Peters MA, Noble PW, Cheifetz IM. Extracorporeal membrane oxygenation for severe refractory respiratory failure secondary to 2009 H1N1 influenza A. Respir Care. 2011 Jul;56(7):941-6 | Device name is not reported |
| Tuzun E, Harms K, Liu D, Dasse KA, Conger J, Richardson JS, Fleischli A, Frazier OH, Radovancevic B. Preclinical testing of the Levitronix Ultramag pediatric cardiac assist device in a lamb model. ASAIO J 2007 May-Jun;53(3):392-396 | Animal study of UltraMag |
| Untaroiu A, Wood HG, Allaire PE. Numerical evaluation of blood damage in a magnetically levitated heart pump - biomed 2009. Biomed Sci Instrum. 2009;45:220-5 | Modeling study |
| Urbańska E, Grzybowski A, Haponiuk I, Przybylski R, Walas W, Stempniewicz K, Szary T, Włoczka G, Skalski JH, Zembala M.(Newborn life threatening respiratory failure treatment with extracorporeal membrane oxygenation). Med Wieku Rozwoj. 2006 Oct-Dec;10(4):1055-65 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Uriel N, Naka Y, Colombo PC, Farr M, Pak SW, Cotarlan V, Albu JB, Gallagher D, Mancini D, Ginsberg HN, Jorde UP. Improved diabetic control in advanced heart failure patients treated with left ventricular assist devices. Eur J Heart Fail. 2011 Feb;13(2):195-9 | Device name is not reported |
| Wagner K, Risnes I, Abdelnoor M, Karlsen HM, Svennevig JL. Is it possible to predict outcome in cardiac ECMO? Analysis of preoperative risk factors. Perfusion. 2007 Jul;22(4):225-9 | Device name is not reported |
| van den Hout L, Schaible T, Cohen-Overbeek TE, Hop W, Siemer J, van de Ven K, Wessel L, Tibboel D, Reiss I. Actual outcome in infants with congenital diaphragmatic hernia: the role of a standardized postnatal treatment protocol. Fetal Diagn Ther. 2011;29(1):55-63 | Device name is not reported |
| VanderPluym CJ, Rebeyka IM, Ross DB, Buchholz H. The use of ventricular assist devices in pediatric patients with univentricular hearts. J Thorac Cardiovasc Surg. 2011 Feb;141(2):588-90 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Wang W, Liao ZK, Hu SS. Peri-operative usage of extracorporeal membrane oxygenation in heart transplantation. Cardiology. 2009;114(S1):42 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Wang JG, Meng X, Han J, Jia YX, Zeng W, Xu CL, Zhang HB, Gao F, Hou XT. (Clinical experience with adults receiving extracorporeal membrane oxygenation for cardiogenic shock and quality of life in survivals). Zhonghua Yi Xue Za Zhi. 2010 Feb 2;90(5):310-4 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Wang S, Haines N, Richardson S, Dasse K, Undar A. Impact of the postpump resistance on pressure-flow waveform and hemodynamic energy level in a neonatal pulsatile centrifugal pump. ASAIO J 2009 May-June;55(3):277-281 | Technical study of CentriMag pump |
| Wang S, Rider A, Kunselman A, Richardson S, Dasse K, Undar A. Effects of the pulsatile flow settings on pulsatile waveforms and hemodynamic energy in a PediVAS centrifugal pump. ASAIO J 2009 May-June;55(3):271-276 | Technical study of CentriMag pump |
| Warnecke G, Kühn C, Olsson KM, Sommer W, Tudorache I, Wiesner O, Hadem J, Simon A, Strüber M, Gottlieb J, Welte T, Hoeper MM, Haverich A. Extracorporeal membrane oxygenation in fully awake patients as bridge to lung transplantation. Thorac and Cardiovasc Surg. 2011;59(S1) | Device name is not reported |
| Wei J, Yang HS, Tsai SK, Hsiung MC, Chang CY, Ou CH, Chang YC, Lee KC, Sue SH, Chou YP. Emergent bedside real-time three-dimensional transesophageal echocardiography in a patient with cardiac arrest following a caesarean section. Eur J Echocardiogr. 2011 Mar;12(3):E16 | Device name is not reported. Case study |
| Weitzel L, Ambardekar A, Brieke A, Cleveland J, Serkova N, Wischmeyer PW, Lowes BD. Heart failure metabolomics by nuclear magnetic resonance and the effects of ventricular assist devices.Circulation. 2011;124(21) | Device name is not reported |
| Westaby S, Poole-Wilson P. Mechanical circulatory support in the UK. BMJ. 2007 Jan 27;334(7586):167-8 | Editorial |
| Westaby S, Shahir A, Sadler G, Flynn F, Ormerod O. Mechanical bridge to recovery in pheochromocytoma myocarditis. Nat Rev Cardiol 2009 Jul;6(7):482-7 | Case report of CentriMag (assessment of clinical effectiveness) |
| Whitson BA, D’Cunha J, Knutsen AC, Boyle AJ, Liao KK. Levitronix ventricular assist devices as a bridge to recovery after profound biventricular heart failure associated with pulmonary aspergillosis. J Heart Lung Transplant 2007 Apr;26(4):345-9 | Case report of CentriMag (assessment of clinical effectiveness) |
| Wilhelm MJ, Sahin A, Staab R, Hasenclever P, Falk V. Emergency ECMO implantation at peripheral hospitals with subsequent patient transport to the tertiary care center. Thorac Cardiovas Surg. 2011;59(S1) | Device name is not reported |
| Villaviccencio M, Larrea R, Larrain E, Turner F, Rivera J,Peralta J P, Reyes A, Munoz P. Puente al trasplante de 4 semanas utilizando el sistema de asistencia ventricular Levitronix Centrimag en el shock cardiogénico post-infarto al miocardio. Caso clínico. Rev Med Chile 2010;138:752-757 | Case report of CentriMag (assessment of clinical effectiveness) |
| Wilmot I, Morales DL, Price JF, Rossano JW, Kim JJ, Decker JA, McGarry MC, Denfield SW, Dreyer WJ, Towbin JA, Jefferies JL. Effectiveness of mechanical circulatory support in children with acute fulminant and persistent myocarditis. J Card Fail. 2011 Jun;17(6):487-94 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Voeller RK, Melby SJ, Grizzell BE, Moazami N. Novel use of plasmapheresis in a patient with heparin-induced thrombocytopenia requiring urgent insertion of a left ventricular assist device under cardiopulmonary bypass. J Thorac Cardiovasc Surg. 2010 Sep;140(3):e56-8 | Device name is not reported. Impact of VAD/ECMO on outcomes is not assessed |
| Wong DT, George K, Wilson J, Manlhiot C, McCrindle BW, Adeli K, Kantor PF. Effectiveness of serial increases in amino-terminal pro-B-type natriuretic peptide levels to indicate the need for mechanical circulatory support in children with acute decompensated heart failure. Am J Cardiol. 2011 Feb 15;107(4):573-8 | Device name is not reported |
| Wu ET, Huang SC, Chen YS, Wang JK, Wu MH, Ko WJ. Children with fulminant myocarditis rescued with extracorporeal membrane oxygenation. Heart. 2006 Sep;92(9):1325-6 | Device name is not reported |
| Wu MY, Lin PJ, Lee MY, Tsai FC, Chu JJ, Chang YS, Haung YK, Liu KS. Using extracorporeal life support to resuscitate adult postcardiotomy cardiogenic shock: treatment strategies and predictors of short-term and midterm survival. Resuscitation. 2010 Sep;81(9):1111-6 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Wu VC, Tsai HB, Yeh YC, Huang TM, Lin YF, Chou NK, Chen YS, Han YY, Chou A, Lin YH, Wu MS, Lin SL, Chen YM, Tsai PR, Ko WJ, Wu KD. NSARF Study Group.Patients supported by extracorporeal membrane oxygenation and acute dialysis: acute physiology and chronic health evaluation score in predicting hospital mortality. Artif Organs. 2010 Oct;34(10):828-35 | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |
| Yang HY, Lin CY, Tsai YT, Lee CY, Tsai CS. Experience of heart transplantation from hemodynamically unstable brain-dead donors with extracorporeal support. Clin Transplant. 2012 Jan 26. doi: 10.1111/j.1399-0012.2011.01585.x | Device name is not reported |
| Yulong Guan, Xiaowei Su, McCoach R, Kunselman A, El-Banayosy A, Undar A. Mechanical performance comparison between RotaFlow and CentriMag centrifugal blood pumps in an adult ECLS model. Perfusion. 2010 Mar;25(2):71-6 | Modeling study |
| Zabrocki LA, Brogan TV, Statler KD, Poss WB, Rollins MD, Bratton SL. Extracorporeal membrane oxygenation for pediatric respiratory failure: Survival and predictors of mortality. Crit Care Med. 2011 Feb;39(2):364-70 | Device name is not reported |
| Zhang J, Taskin M, Koert A, Zhang T, Gellman B, Dasse K, Gilbert R, Griffith B, Wu Z.  Computational design and in vitro characterization of an integrated maglev pump-oxygenator.  Artif Organs. 2009 Oct;33(10):805-17 | Technical study of CentriMag pump |
| Zhang T, Cheng G, Koert A, Zhang J, Gellman B, Yankey G, Satpute A, Dasse K, Gilbert R, Griffith B, Wu Z. Functional and biocompatibility performance of an integrated maglev pump-oxygenator.  Artif Organs 2009 Jan;33(1):36-45 | Technical and animal study of CentriMag pump |
| Zhang J, Koert A, Gellman B, Gempp TM, Dasse KA, Gilbert RJ, Griffith BP,  Wu Z. Optimization of a miniature maglev ventricular assist device for pediatric circulatory support. ASAIO J 2007 Jan-Feb;53(1):23-31 | Technical study of CentriMag pump |
| Zhang J, Gellman B, Koert A, Dasse K, Gilbert RJ, Griffith B, Wu ZJ. Computational and experimental evaluation of the fluid dynamics and hemocompatibility of the CentriMag blood pump. Artif Organs 2006;30(3):168-177 | Technical study of CentriMag pump |
| Zhu DM, Wang W, Chen H, Xu ZW, Cao DF, Ding WX. Left ventricular assist device for pediatric postcardiotomy cardiac failure. ASAIO J 2006 Sep-Oct;52(5):603-4. | Device used is not magnetically levitated centrifugal pump CentriMag or PediVAS/PediMag, manufactured by Levitronix or Thoratec |

# Identification of duplicate publications

Publications were analyzed within the following groups to allow identification and exclusion of duplicate publications.

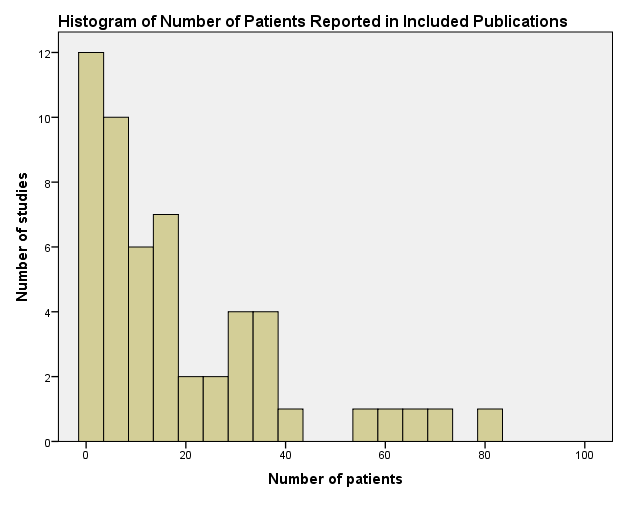
* **Publications from Herzzentrum (Bad Oeynhausen, Germany):** El-Banayosy, 200666; Chung et al., 200720.
* **Publications from Hershey Medical Centre (Hershey, Pennsylvania, USA):** Aziz et al., 201013; Soleimani et al., 201150.
* **Publications from Harefield Hospital (Harefield, UK):** De Robertis et al., 200568; De Robertis et al., 200610; De Robertis et al., 200811; Haj-Yahia et al., 200927; Bindoff et al., 200915; Firouzi et al., 201069; Santise et al., 200647; Zych et al., 201157.
* **Publications from Texas Heart Institute/St. Luke's Episcopal Hospital (Houston, Texas, USA):** Akay et al., 201112; John et al., 201130.
* **Publications from Pediatric Heart Centre (Sankt Augustin, Germany):** Reckers et al., 200670; Reckers et al., 200845.
* **Publications from University of Minnesota (Minneapolis, Minnesota, USA):** John et al., 200671; John et al., 200729; John et al., 201130; Ziemba et al., 201072; Marquez et al., 200938.
* **Publications from Intermountain Medical Center (Salt Lake City, UT, USA):** Kouretas et al., 200932; McCormick et al., 201039.
* **Publications from Deutsches Herzzentrum Berlin (Berlin, Germany) and San Camillo Hospital (Rome, Italy):** Loforte et al., 201135; Loforte et al., 2010a36; Loforte et al., 2010b33; Loforte et al., 2009a34; Loforte et al., 2009b73; Stepanenko et al., 201174; Stepanenko et al., 201051.
* **Publications from Columbia University Medical Centre (New York, NY, USA):** Takayama et al., 201253; Takayama et al., 201152; Worku et al., 201155; Yang et al., 201056; Melnitchouk et al., 201175; Morgan et al., 200941; Sims et al., 201159; Chen et al., 201019; Hirata et al., 200876; Singh et al., 200949; Smerling et al., 200977.

# Excluded duplicate publications

**Table 5. List of excluded duplicate publications**

|  |  |
| --- | --- |
| **Study reference** | **Reason for exclusion** |
| DeRobertis et al., 200568 | There is a high risk of reporting outcomes for the same patient group as in the studies of De Robertis et al. (2006)10 and DeRobertis et al. (2008)11, which were included into review. Publication presents early experience of Harefield Hospital in using CentriMag for ventricular assistance, which was presented more extensively in later publications from the same institution |
| El-Banayosy, 200667 | There is a high risk of reporting outcomes for the same patient group, as in publication of Chung et al. (2007)20, which was included into review |
| Hirata et al., 200876 | There is a high risk of reporting outcomes for the same patient group, as in publication Chen et al. (2010)19, which was included into review |
| John et al., 2006a78 | There is a high risk of reporting outcomes for the same patient group, as in the publication John et al. (2007)29, which was included into review |
| John et al., 2006b71 | There is a high risk of reporting outcomes for the same patient group, as in the publication John et al. (2007)29, which was included into review |
| Loforte et al., 2009b73 | There is a high risk of reporting outcomes for the same patient group, as in publication Loforte et al. (2011)35, which was included into review |
| Melnitchouk et al., 201175 | There is a risk of reporting outcomes for the same patient group, as in publication Worku et al. (2011)55, which was included into review |
| Reckers et al., 200670 | There is a high risk of reporting outcomes for the same patient group, as in publication Reckers et al. (2008)45, which is included into review |
| Smerling et al., 200976 | There is a high risk of reporting outcomes for the same patient group, as in publication Chen et al. (2010)19, which is included into review |
| Stepanenko et al., 201174 | According to one of the authors (Dr A. Loforte, personal communication), 10 out of 27 patients, who were reported in this paper, were also reported in publication Loforte et al. (2011)35, which is included into review |
| Worku et al., 201079 | There is a high risk of reporting outcomes for the same patient group, as in publication Worku et al. (2011)55, which is included into review |
| Ziemba et al., 201072 | There is a high risk of reporting outcomes for the same patient group, as in publication John et al. (2007)29, which is included into review |

# Analysis of included publications



**Figure 6. Number of patients reported in included publications**

**Online supplemental information. Additional Description of Identified Studies**

Thirty four publications (64%) did not report their approach to data collection. Eight (15%) studies also reported outcomes for other heart pumps, whilst remaining 45 (85%) publications reported only CentriMag experience.

One study reported international (UK and Germany) experience (20). The location was not reported in 2 publications33, 51.

Four (8%) publications7, 8, 20, 29 presented multi-centre experience, whilst the remaining 49 (92%) studies were conducted in a single centre.

Mean age of patients in 31 studies, which report these data, was 43.8 years. Average age of patients in paediatric studies was 9.3 years, in studies, which involved adult patients, - 48.9 years, and in studies in mixed population – 43.4 years.

Details of clinical indications are provided for 552 patients (55%).

Two studies reported the preventive usage of CentriMag VAD in high risk patients, either during cardiac surgery54 or LVAD implantation36. Two studies reported a novel approach to percutaneous CentriMag RVAD placement49, 53.

Thirty-nine (73%) publications were presented in full-text format, whilst the remaining 14 (27%) publications were only available as conference proceedings’ abstracts (with no full text available).

No statistical analysis was performed in the majority of studies due to the nature of case-series studies. However, descriptive statistics were used to describe patient characteristics and resource utilisation. Subgroup analysis was not performed in the majority of studies. Survival at different time periods was reported in 92% (n=49) studies, weaning from support – in 70% (n=70%), bridging patients to long-term VAD or heart transplant – in 58% (n=31) of the studies. The most prevalent survival data reported were survival on support (reported in 30 studies, 57%), survival at discharge from hospital (reported in 29 studies, 55%) and 30-day survival (reported in 17 studies (32%). Safety outcomes were reported in 41 (77%) studies. Thirteen (32%) of the studies report number of adverse events, while remaining 28 (68%) of the studies report number of patients, who experienced adverse events, although majority of the studies, reporting number of events rather state that no adverse events were observed, except two studies, which provide detailed information about number of events experienced and number of events per patient8, 30. The most commonly reported safety outcomes were: bleeding (reported in 22 studies, 42%), device performance (reported in 22 studies, 42%), thrombosis (reported in 18 studies, 34%) and neurologic complications (reported in 15 studies, 28%).

# Effectiveness outcomes in the included studies (mixed indication)

**Table 6. Effectiveness outcomes in the included studies**

| Study | Sample size | Patient group. % of patients | | | | | Duration of support | | Survival. % of patients | | | | | | | Clinical outcomes. % of patients | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Pre-cardiotomy | Post-Cardiac Surgery | Post- HTx | Post-LVAD | Respiratory failure | Mean (SD) | Range | On support | At discharge | 30-day | 90-day | 6-month | 1-year | After 1-year | Weaned | Bridged HTx | Bridged VAD |
| VAD support for mixed group of patients | | | | | | | | | | | | | | | | | | |
| Bindoff 15 | 29 | - | - | - | - | - | NR | - | - | - | - | - | - | - | - | - | - | - |
| Cassidy18 | 3 | - | - | - | - | - | 10 | 5-16 | - | 100 | - | - | - | - | - | - | 100 | - |
| Chen19 (BiVAD) | 11 | - | - | - | - | - | 12.1 (8.4)\*\* | - | 64 | - | - | - | - | - | - | - | 64 | - |
| Chen19 (CentriMag/  Impella) | 3 | - | - | - | - | - | 5 (2) | - | 100 | - | - | - | - | - | - | 100 | - | - |
| den Uil22 | 2 | - | - | - | - | - | 7 | 6-7 | 100 | - | - | - | - | - | - | 100 | - | - |
| Loforte33 | 36 | - | - | - | - | - | 9.9 (6.6) | 3-20 | - | - | 53 | - | - | - | - | 39 | 6 | 0 |
| Takayama52 | 63 | - | - | - | - | - | NR | - | - | - | - | - | - | - | - | - | - | - |
| Worku55 | 56 | - | - | - | - | - | 16\*\*\*\* | - | - | - | - | - | - | - | - | - | - | - |
| De Robertis10 | 12 | 0 | 58 | 17 | 25 | 0 | 14.2 (15.2)\*\*\* | 1-64 | 67 | 42 | 50 | - | - | - | - | - | 17 | 8 |
| Horváth28 | 20 | 65 | 15 | 15 | 5 | 0 | 25.3 (16.5) | 5-71 | 65 | - | 70 | - | - | - | - | 25 | 35 | 5 |
| Favaloro24 | 4 | 25 | 75 | 0 | 0 | 0 | 8.25 | 4-18 | 25 | 25 | - | - | - | - | 25 | - | 50 | - |
| Kouretas32 | 2 | 0 | 50 | 50 | 0 | 0 | 4.5 | 3-6 | 100 | 100 | - | - | - | - | - | 50 | - | 50 |
| Pawlak44 | 2 | 50 | 0 | 50 | 0 | 0 | NR | 13-21 | 50 | - | - | - | - | - | - | 50 | - | - |
| Takayama53 | 8 | 38 | 25 | 25 | 13 | 0 | NR | - | 88 | 88 | - | - | - | - | - | 38 | - | 38 |
| ECMO support for mixed group of patients | | | | | | | | | | | | | | | | | | |
| Aziz13 | 10 | 60 | 20 | 20 | 0 | 0 | 5.8 (4) | 1-14 | 60 | 60 |  |  |  |  |  |  |  | 10 |
| Bruschi16 | 14 | 64 | 21 | 14 | 0 | 0 | 12 | 3-30 |  |  |  |  |  |  |  | 29 | 21 | 7 |
| Byrnes17 | 7 | - | - | - | - | - | 9.5 | - | - | 43 | - | - | - | - | - | - | - | - |
| DiBella23 | 6 | - | - | - | - | - | NR | 6-20 | - | - | - | - | - | - | - | 33 | - | 17 |
| Khan31 | 3 | 0 | 0 | 67 | 0 | 33 | 3.7 | 2-6 | - | 67 | - | - | - | - | - | 67 | - | - |
| Reckers45 | 33 | - | - | - | - | - | 9.3 | 2-24 | 57 | - | - | - | - | - | - |  | - | - |
| Soleimani50 | 34 | - | - | - | - | - | 6\* | 1-40 | - | 55 | - | - | - | - | - | 47 | 3 | 6 |
| Meyer40 | 18 | 6 | 67 | 28 | 0 | 0 | 4.3 | 1-14 | - | 39 | 44 | - | - | - | - | 67 | - | - |
| UK ECMO Service Evaluation7 | 67 | 31 | 25 | 7 | 0 | 36 | 6.9 (5.78) | 1-31 | - | 67 | 76 | 64 | - | - | - | - | - | - |
| Chung20 | 70 | - | - | - | - | - | 8.2 (8.1) | - | 53 | 25 | - | - | - | - | - | 28 | 1 | 23 |

\*Median duration of support.

\*\*Chen 2012: mean duration of support 12.1 days is from CentriMag BiVAD group (n=10), while duration of support for one patient on PediVAS BiVAD was 17 days.

\*\*\*Duration of support for the whole group (n=18) irrespective of indication.

\*\*\*\*Duration of support for the whole group (n=56) irrespective of indication.

# Meta-analysis of effectiveness and safety outcomes

## Table 7. Meta-analysis of effectiveness outcomes, survival (random-effect model)

| Indication | Survival, percentage (95% confidence interval), I2 | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| N studies (n pts) | On support | N studies (n pts) | At discharge | N studies (n pts) | 30-day | N studies (n pts) | 90-day | N studies (n pts) | 6-month | N studies (n pts) | 1-year |
| VAD support in pre-cardiotomy cardiogenic shock indication | 5 (45) | 78%  (48-97%), I2=75.4% | 3 (23) | 75%  (32-99%), I2=74.2% | 6 (69) | 67%  (45-86%), I2=71.7% | 3 (29) | 78%  (45-98%), I2=67.3% | 4 (46) | 73%  (47-93%), I2=69.2% | 3 (32) | 78%  (47-97%), I2=67% |
| VAD support in post-cardiac surgery cardiogenic shock indication | 4 (32) | 79%  (43-99%),  I2=62.3% | 6 (32) | 61%  (29-88%),  I2= 65% | 5 (65) | 41%  (30-54%), I2= 0% | - | - | 2 (20) | 37%  (3-82%),  I2= 78.4% | - | - |
| VAD support in post-transplant graft rejection or failure indication | 3 (40) | 91%  (35-100%), I2= 84.1% | 2 (12) | 84%  (23-100%), I2= 68% | 3 (45) | 54%  (39-68%), I2= 0% | - | - | - | - | - | - |
| VAD support in post-LVAD placement right ventricular failure indication | 6 (58) | 87%  (70-97%), I2= 57% | 4 (54) | 67%  (38-91%), I2=77.5% | 3 (41) | 40%  (2-88%), I2=90% | - | - | - | - | - | - |

Pts – patients; VAD, ventricular assist device.

## Table 8. Meta-analysis of effectiveness outcomes, weaning from support or bridging to repeat heart transplant or VAD (random-effect model)

| Indication | Survival, percentage (95% confidence interval), I2 | | | |
| --- | --- | --- | --- | --- |
| N studies (n pts) | Proportion of patients weaned from support or bridged to heart transplant or bridged to VAD (95% CI) | N studies  (n pts) | Proportion of patients weaned from support or bridged to heart transplant (95% CI) |
| VAD support in post-transplant graft rejection or failure indication | - | - | 5 (55) | 81%  (54-98%), I2=70.3% |
| VAD support in post-LVAD placement right ventricular failure indication | 8 (82) | 80%  (64-92%), I2=58.6% | - | - |

Pts – patients; VAD, ventricular assist device.

**Table 9. Meta-analysis of effectiveness outcomes in the included studies, weaning from support or bridging to repeat heart transplant or VAD (fixed-effect model)**

| Indication | Survival, percentage (95% confidence interval) | | | |
| --- | --- | --- | --- | --- |
| N studies  (n pts) | Proportion of patients weaned from support or bridged to heart transplant or bridged to VAD (95% CI) | N studies  (n pts) | Proportion of patients weaned from support or bridged to heart transplant (95% CI) |
| VAD support in post-transplant graft rejection or failure indication | - | - | 5 (55) | 65%  (52-77%) |
| VAD support in post-LVAD placement right ventricular failure indication | 8 (82) | 77%  (67-85%) | - | - |

Pts – patients; VAD, ventricular assist device.

## Table 10. Meta-analysis of effectiveness outcomes with exclusion of studies, which contribute to heterogeneity (random-effect model)

| Indication | Survival, percentage (95% confidence interval), I2 | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| N studies (n pts) | On support | N studies (n pts) | At discharge | N studies (n pts) | 30-day |
| VAD support in pre-cardiotomy cardiogenic shock indication | 4 (40) | 88%  (70-99%), I2=50.9% | - | - | 5 (60) | 74%  (56-87%), I2=56% |
| VAD support in post-LVAD placement right ventricular failure indication | - | - | 3 (48) | 54%  (40-68%), I2= 0% | 2 (36) | 71%  (50-88%), I2= 39.7% |

Pts – patients; VAD, ventricular assist device.

## Table 11. Meta-analysis of effectiveness outcomes with exclusion of studies, which contribute to heterogeneity (fixed-effect model)

| Indication | Survival, percentage (95% confidence interval) | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| N studies (n pts) | On support | N studies (n pts) | At discharge | N studies (n pts) | 30-day |
| VAD support in pre-cardiotomy cardiogenic shock indication | 4 (40) | 88%  (76-96%) | - | - | 5 (60) | 72%  (60-83%) |
| VAD support in post-LVAD placement right ventricular failure indication | - | - | 3 (48) | 54%  (40-68%) | 2 (36) | 73%  (57-86%) |

Pts – patients; VAD, ventricular assist device.

## Table 12. Meta-analysis of adverse events (proportion of patients experienced adverse event) (random-effect model)

|  |  |  |
| --- | --- | --- |
| Adverse event | N studies (n pts) | Adverse event, percentage (95% confidence interval), I2 |
| Bleeding | 21 (398) | 26% (18-35%), I2=70.7% |
| Thrombosis and thromboembolism | 16 (245) | 5% (1-12%), I2= 64.5% |
| Haemolysis | 6 (164) | 2% (0-6%), I2=34.2% |
| Neurologic complications | 13 (266) | 5% (2-11%), I2=52.5% |
| Infection | 10 (251) | 22% (10-35%), I2=82.4% |
| Renal complications | 7 (164) | 30% (7-59%), I2=92.4% |
| Device failure | 21 (512) | 0% (0-0.01%), I2=0% |
| Device failure (with exclusion of studies with sample size less than 10) | 14 (480) | 0% (0-0.0%), I2=0% |

Pts – patients.

## Table 13. Meta-analysis of adverse events (proportion of patients experienced adverse event) (fixed-effect model)

|  |  |  |
| --- | --- | --- |
| Adverse event | N studies (n pts) | Adverse event, percentage (95% confidence interval) |
| Bleeding | 21 (398) | 28% (23-32%) |
| Thrombosis and thromboembolism | 16 (245) | 7% (5-11%) |
| Haemolysis | 6 (164) | 3% (1-6%) |
| Neurologic complications | 13 (266) | 7% (4-11%) |
| Infection | 10 (251) | 24% (19-30%) |
| Renal complications | 7 (164) | 28% (22-36%) |
| Device failure | 21 (512) | 0% (0-0.01%) |
| Device failure (with exclusion of studies with sample size less than 10) | 14 (480) | 0% (0-0.0%) |

Pts – patients.

**Effectiveness Outcomes of Studies, Which Had Comparative Design or Statistical Analysis**

Six original studies had comparative design or provided statistical analysis of outcomes (Thomas et al., 2011 (8); Worku et al., 201155; Akay et al., 2011 (12); Byrnes et al., 201117; Cassidy et al., 200918 and ECMO Service Evaluation7). The remaining 45 studies, which reported effectiveness outcomes, were designed as case-series studies and did not employ statistical analysis.

The UK Cardiothoracic Transplant Audit analyzed all adult cases of CentriMag support after early cardiac allograft failure8. CentriMag was used in majority of cases, where mechanical support was required. Survival analysis was performed with 30-day survival estimated at 50%.

Worku et al. 2011 presented analysis of short-term VAD support of 93 patients at Columbia University Medical Center (New York, USA)55. Two devices were used (CentriMag and Abiomed BVS5000 (Abiomed Inc., Danvers, MA)). The Abiomed device was found to be independent predictor of hospital mortality in univariate (p=0.009), but not in multivariate (odds ratio 2.12, p=0.325) analysis.

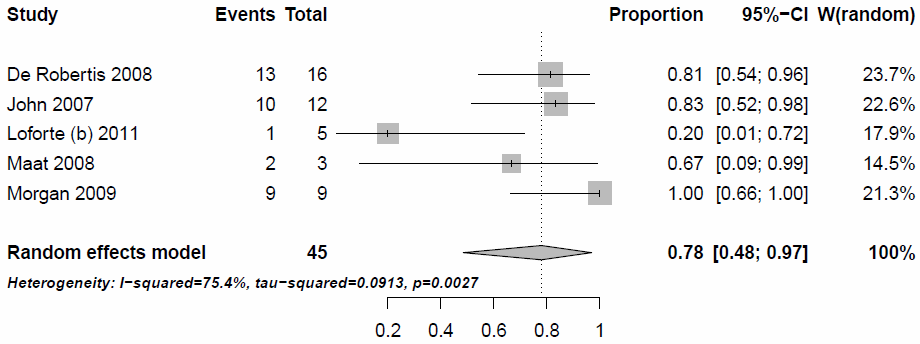
Study from Texas Heart Institute analyzed 30-day survival in patients, supported with CentriMag immediately after failing attempt to wean patients from cardiopulmonary bypass or with delay after transfer to ICU12. Group of immediate support (in which CentriMag was placed in the operating room) had statistically significantly higher survival (70%) in comparison with the group of delayed (in which CentriMag was placed after transfer to ICU) support (17%), p=0.027.

Study of Cassidy et al. 2009 presented experience of Freeman Hospital, UK with bridging pediatric patients to heart transplant18. Small number of patients (n=3) were supported with CentriMag and all of them survival to transplant. Survival-to-transplant was 67% in ECMO support group, 77% in Berlin Heart group, and 57% in Medos device group. Statistical analysis was not employed for comparative analysis of survival on different devices.

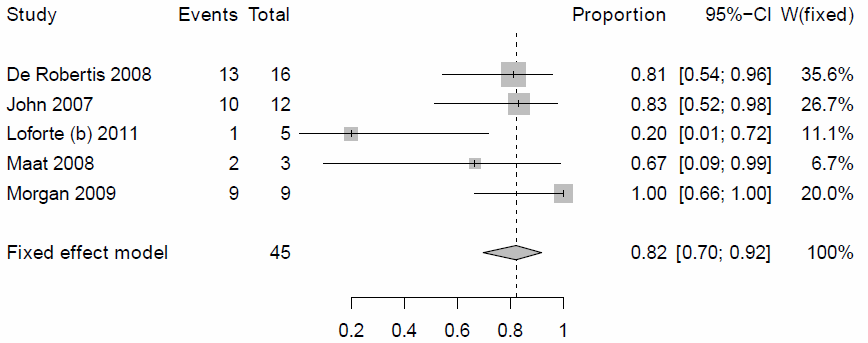
Retrospective matched cohort study of Byrnes et al. 2011 compared hemolysis and circuit failure rates in patients, supported with centrifugal (CentriMag) and roller (Stockert-Shiley SIII) ECMO systems17. Patients in the roller pump group had significantly higher risk of hemolysis (odds ratio 1.96, p<0.014) and higher risk of circuit change (7 changes in 14 patients compared with 1 change in 7 patients supported with CentriMag, p=0.174).

Unpublished ECMO Service Evaluation in the UK provided analysis on outcomes in patients, supported with centrifugal (CentriMag) and roller ECMO systems7. In total 134 patients were retrospectively matched in 1:1 manner. While no significant differences were found in patient baseline characteristics or ECMO support mode, centrifugal pumps showed much better safety (0 vs. 8 device malfunctions, p=0.008), improved median survival ((128 days, 95% CI 81-174 days on centrifugal vs. 35 days, 95% CI 14-55 days on roller pump, (log rank test, p=0.028)), and reduced resource utilization (volume of red blood cells transfused, p=007; volume of thrombocytes transfused, p=0.02).

## Technical data. VAD support in pre-cardiotomy cardiogenic shock indication

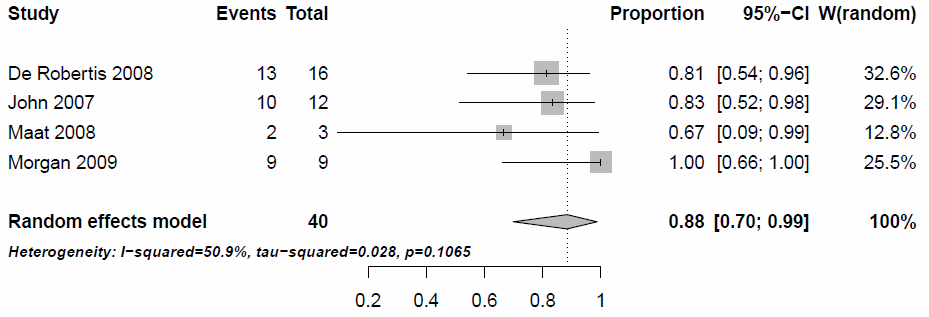


**Figure 7. Survival on support (R-E model)**

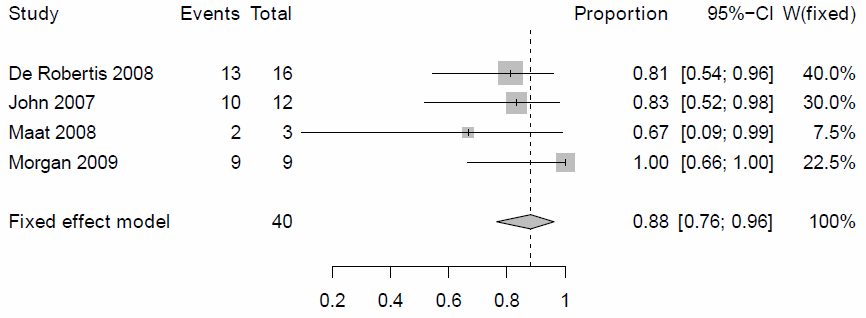


**Figure 8. Survival on support (F-E model)**

**Analysis with exclusion of study of Loforte 2011, which contribute the most to heterogeneity of results**

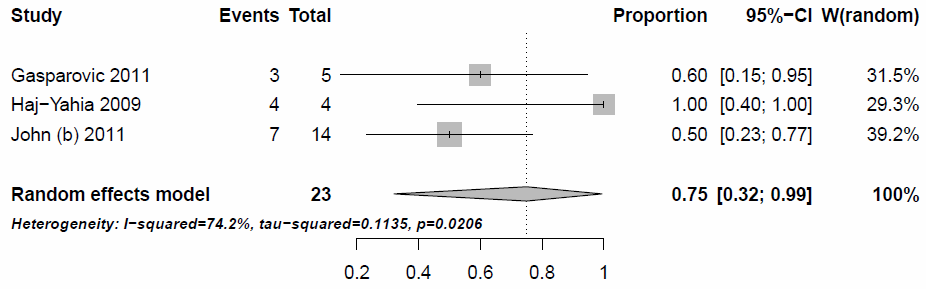


**Figure 9. Survival on support (R-E model) (Loforte 2011 excluded)**

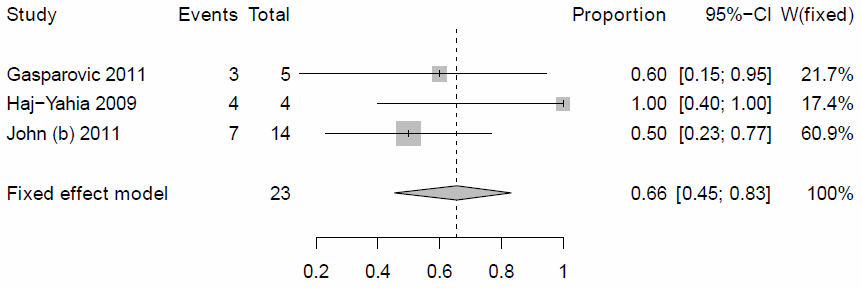


**Figure 10. Survival on support (F-E model) (Loforte 2011 excluded)**

**Survival at discharge**

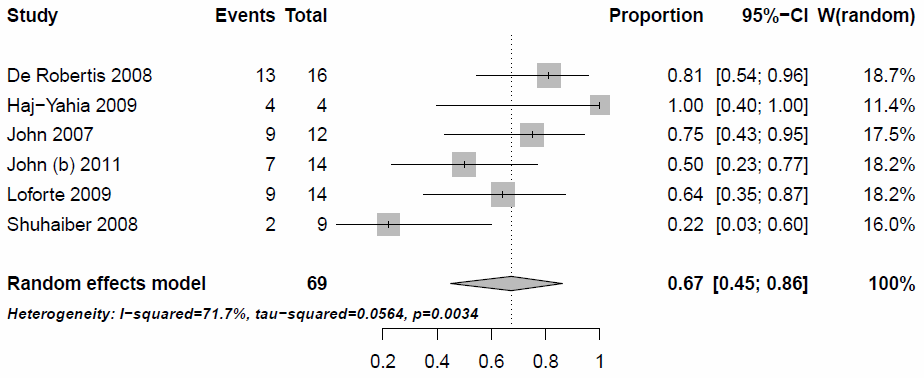


**Figure 11. Survival at discharge (R-E model)**

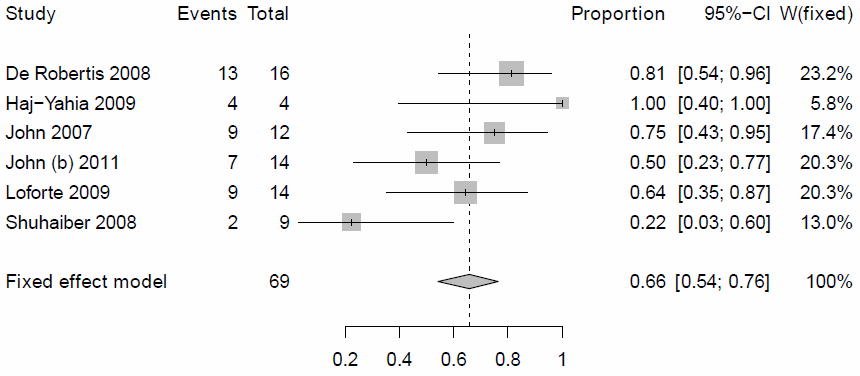


**Figure 12. Survival at discharge (F-E model)**

**30-day survival**

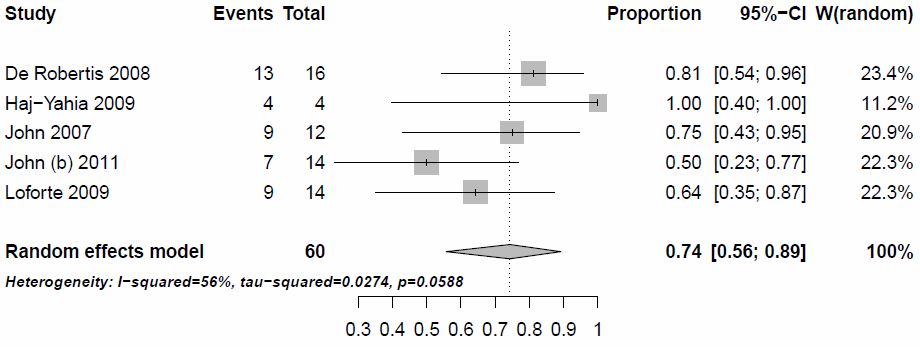


**Figure 13. 30-day survival (R-E model)**

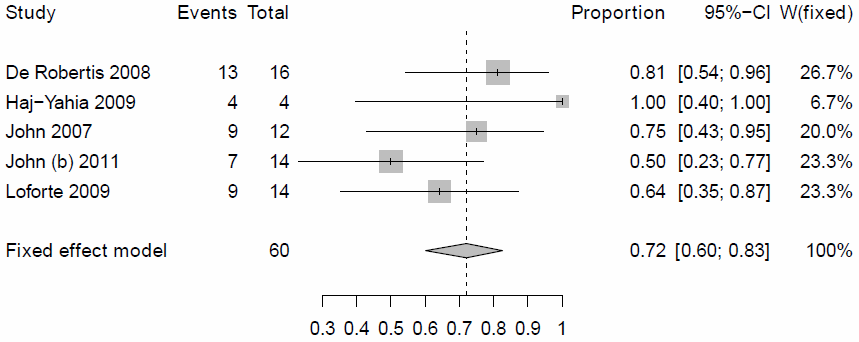


**Figure 14. 30-day survival (F-E model)**

**Analysis with exclusion of study of Shuhaiber 2008, which contribute the most to heterogeneity of results**

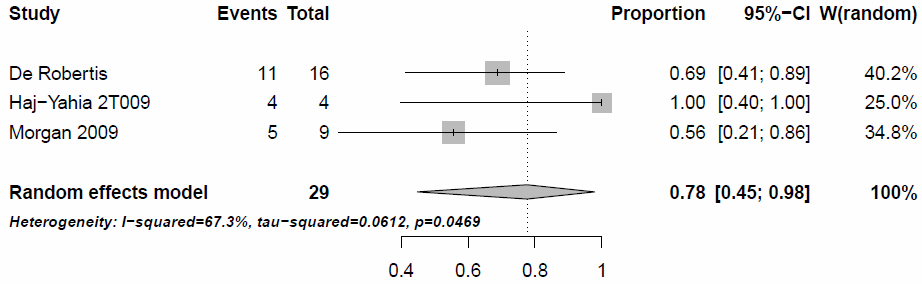


**Figure 15. 30-day survival (R-E model), Shuhaiber 2008 excluded**

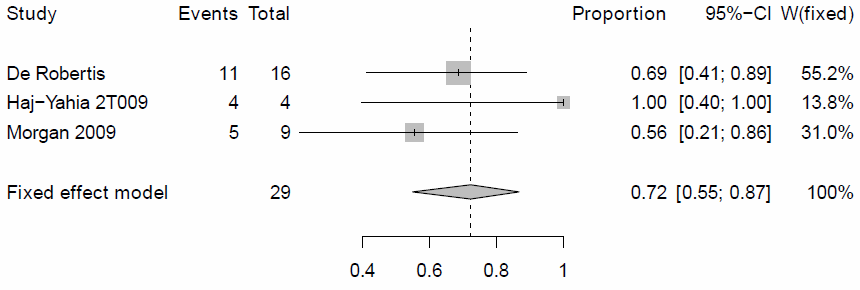


**Figure 16. 30-day survival (F-E model), Shuhaiber 2008 excluded**

**90-day survival**

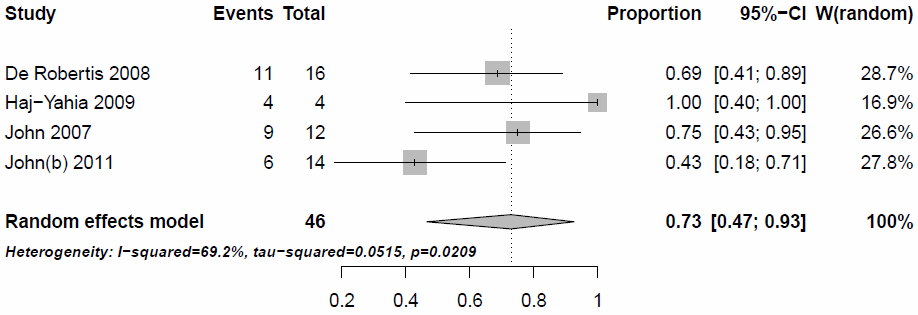


**Figure 17. 90-day survival (R-E model)**

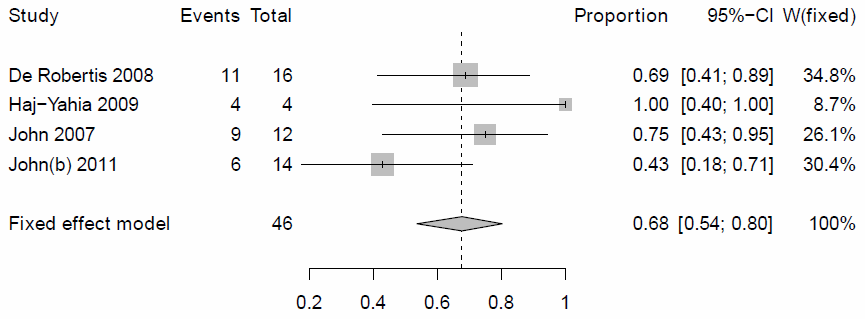


**Figure 18. 90-day survival (F-E model)**

**6-month survival**

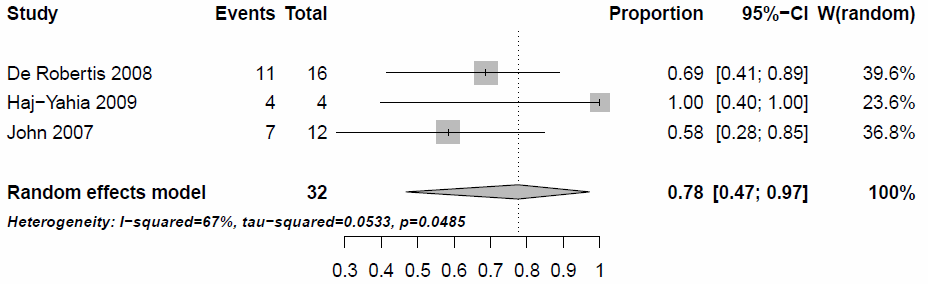


**Figure 19. 6-month survival (R-E model)**

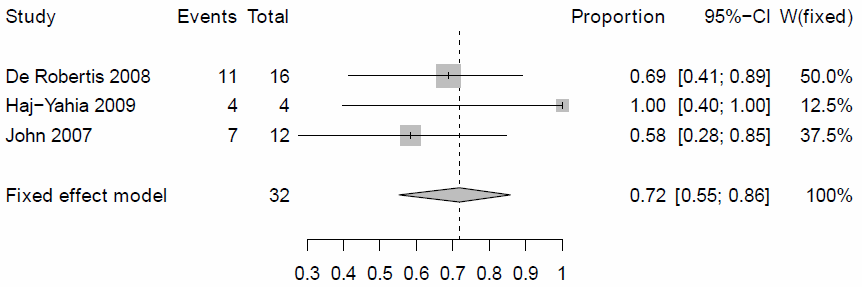


**Figure 20. 6-month survival (F-E model)**

**1-year survival**



**Figure 21. 1-year survival (R-E model)**



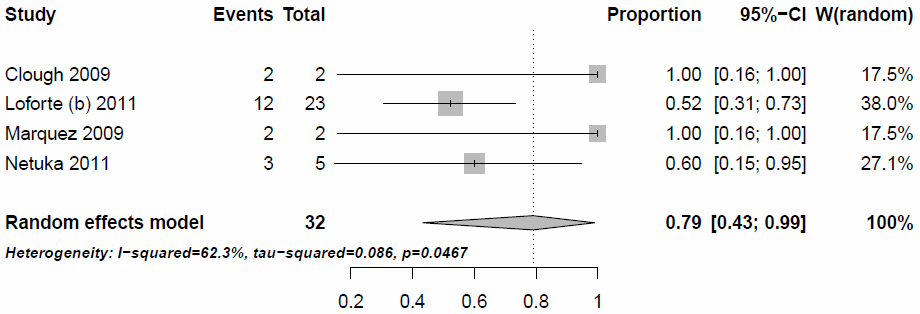
**Figure 22. 1-year survival (F-E model)**

**Post-1-year survival**

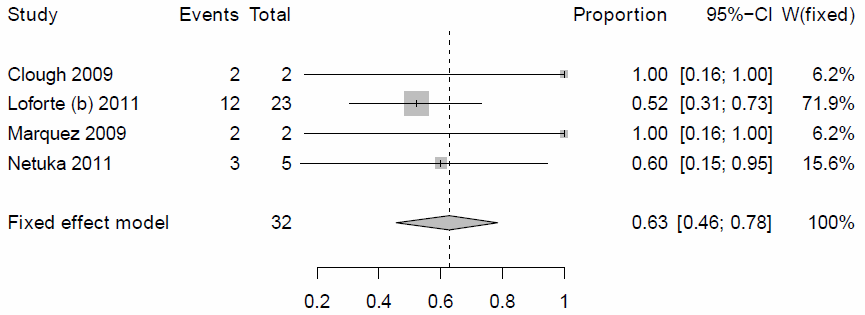
Not applicable

## Technical data. VAD support in post-cardiac surgery cardiogenic shock indication

**Survival on support**

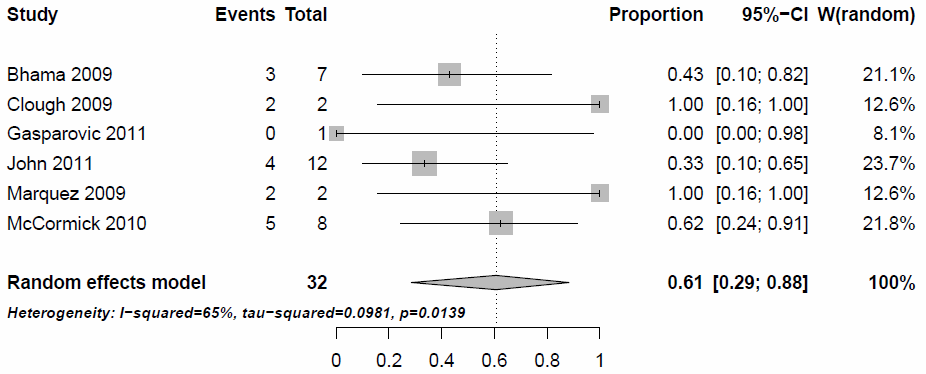


**Figure 23. Survival on support (R-E model)**

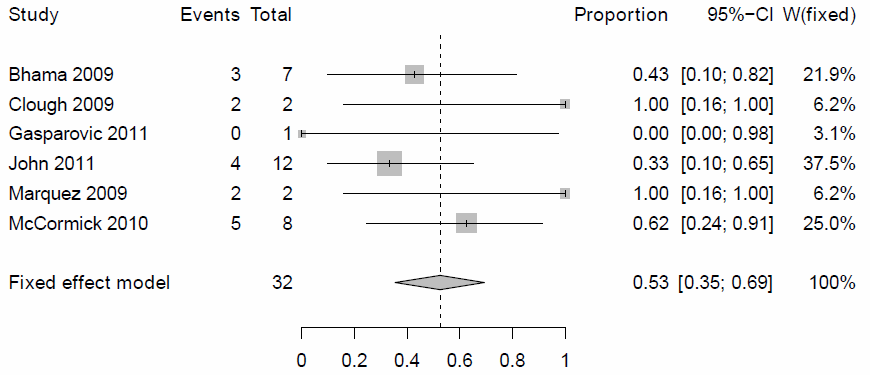


**Figure 24. Survival on support (F-E model)**

**Survival at discharge**

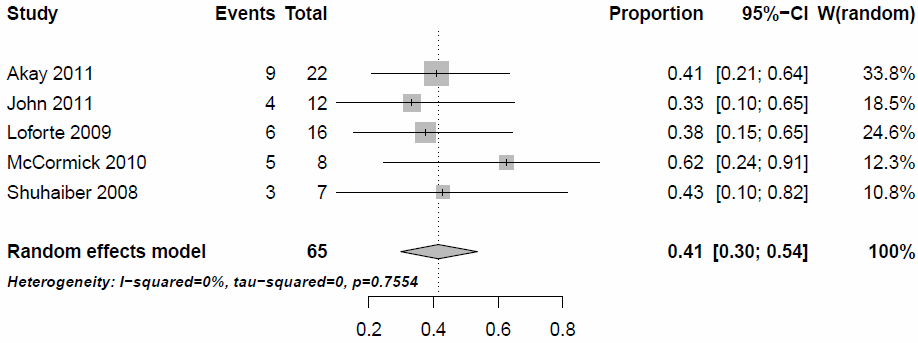


**Figure 25. Survival at discharge (R-E model)**

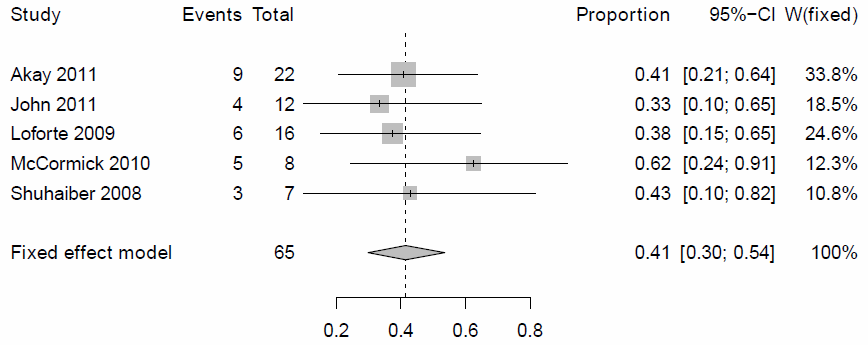


**Figure 26. Survival at discharge (F-E model)**

**30-day survival**



**Figure 27. 30-day survival (R-E model)**

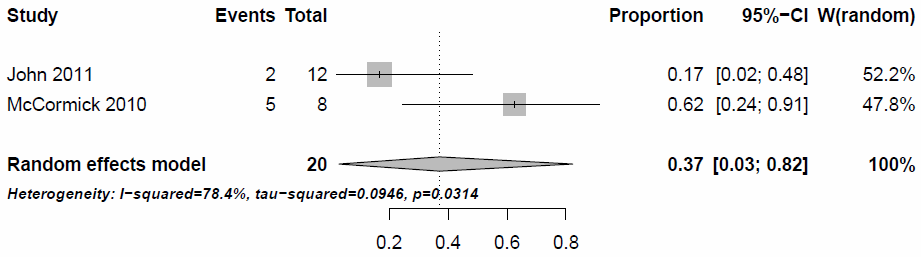


**Figure 28. 30-day survival (F-E model)**

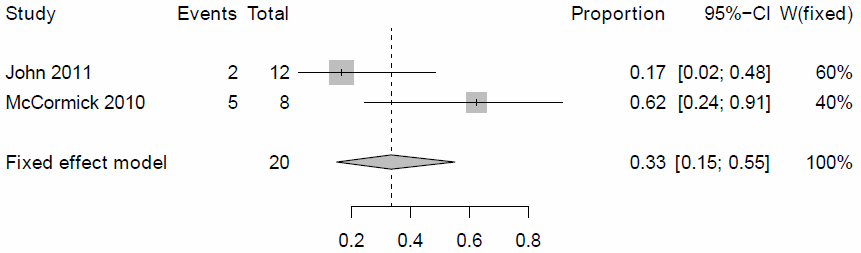
**90-day survival**

Not applicable

**6-month survival**



**Figure 29. 6-month survival (R-E model)**



**Figure 30. 6-month survival (F-E model)**

**1-year survival**

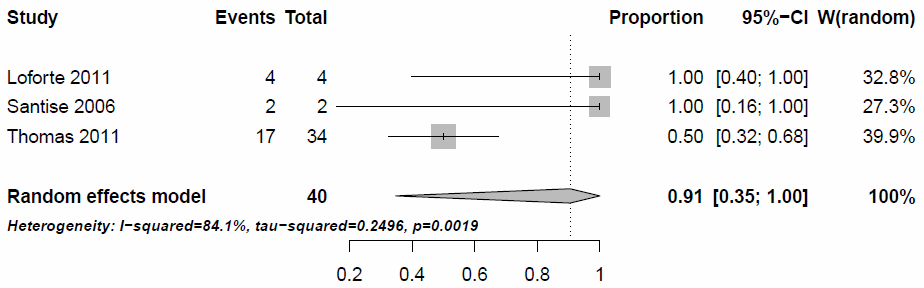
Not applicable

**Post-1-year survival**

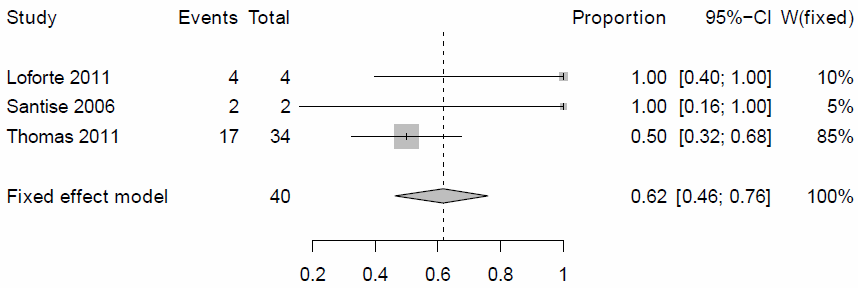
Not applicable

## Technical data. VAD support in post-transplant graft rejection or failure indication

**Survival on support**

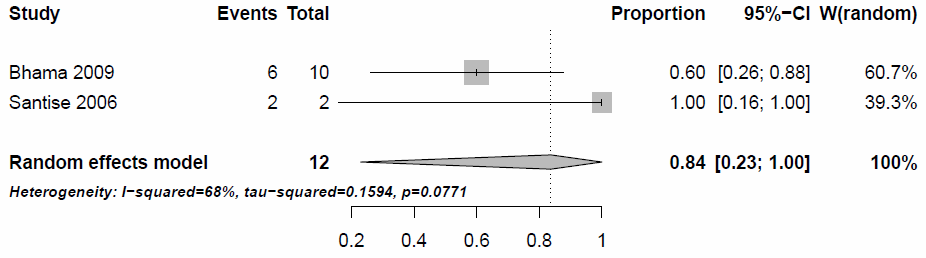


**Figure 31. Survival on support (R-E model)**

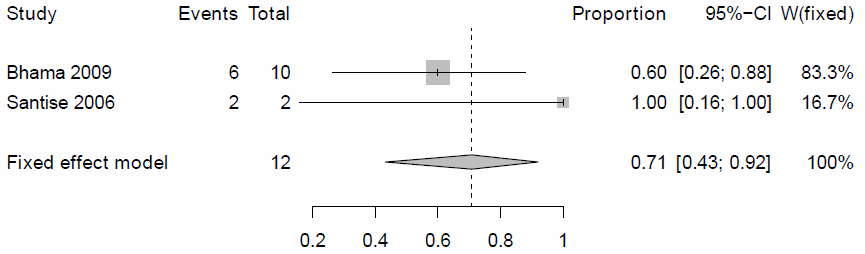


**Figure 32. Survival on support (F-E model)**

**Survival at discharge**

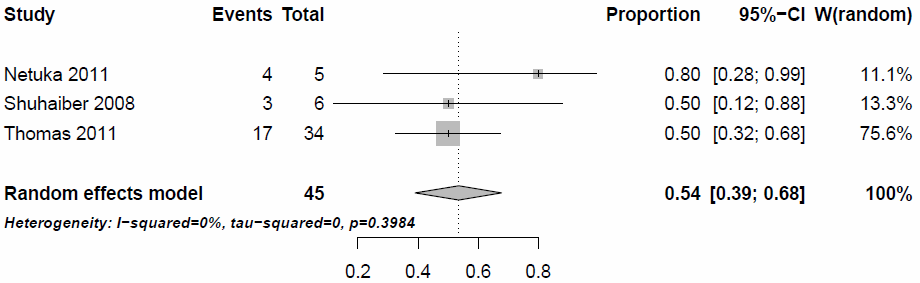


**Figure 33. Survival at discharge (R-E model)**

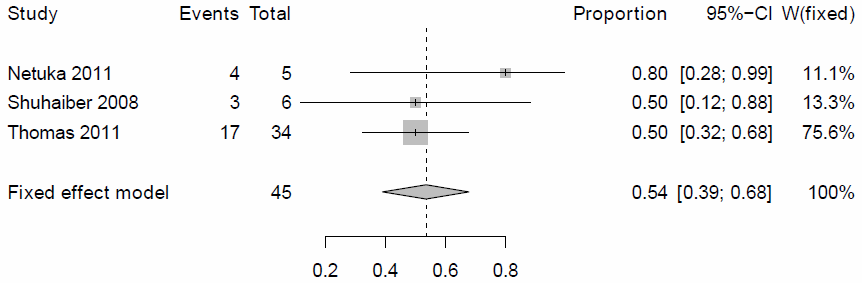


**Figure 34. Survival at discharge (F-E model)**

**30-day survival**

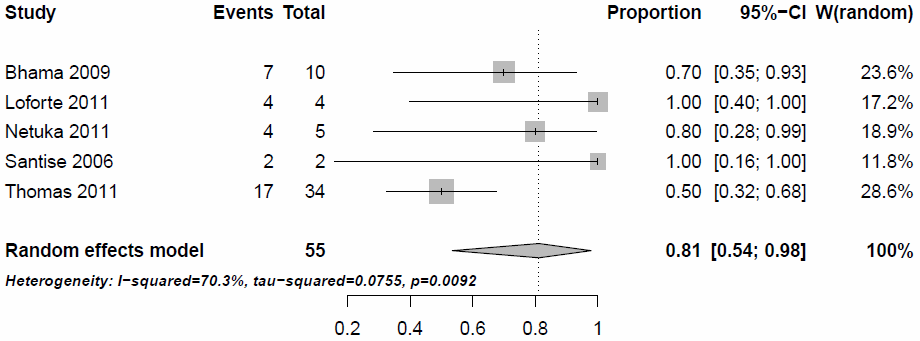


**Figure 35. 30-day survival (R-E model)**

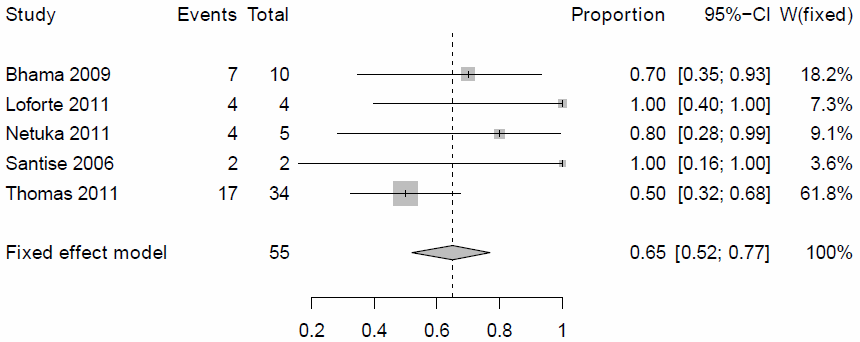


**Figure 36. 30-day survival (F-E model)**

**Weaned from support or bridged to repeat heart transplant**



**Figure 37. Weaned from support or bridged to repeat heart transplant (R-E model)**



**Figure 38. Weaned from support or bridged to repeat heart transplant (F-E model)**

**6-month survival**

Not applicable

**1-year survival**

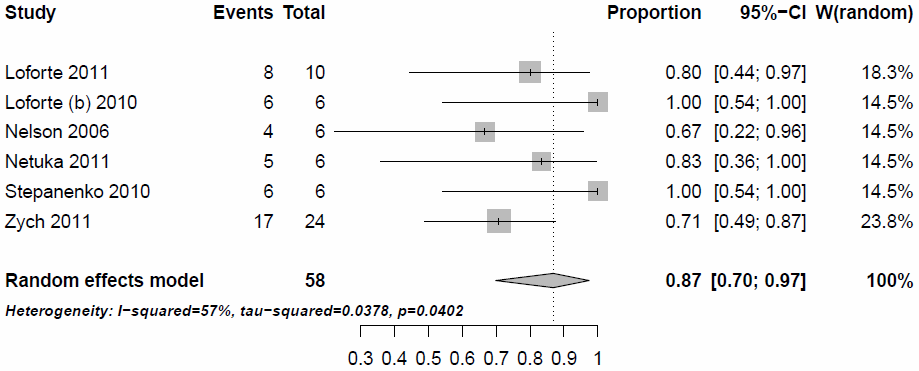
Not applicable

**Post-1-year survival**

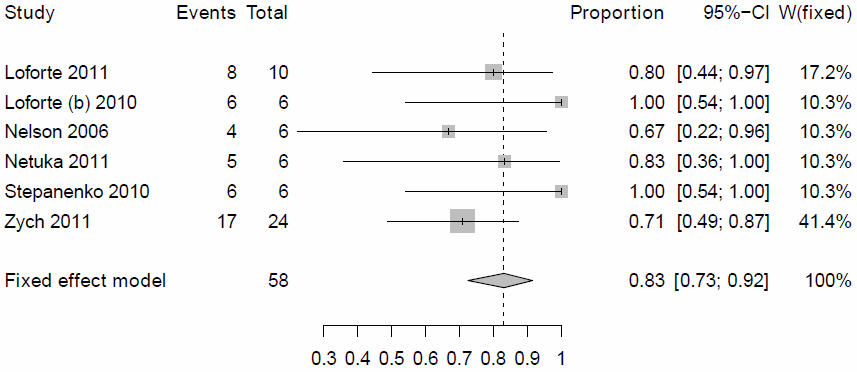
Not applicable

## Technical data. Post-LVAD placement right ventricular failure indication

**Survival on support**

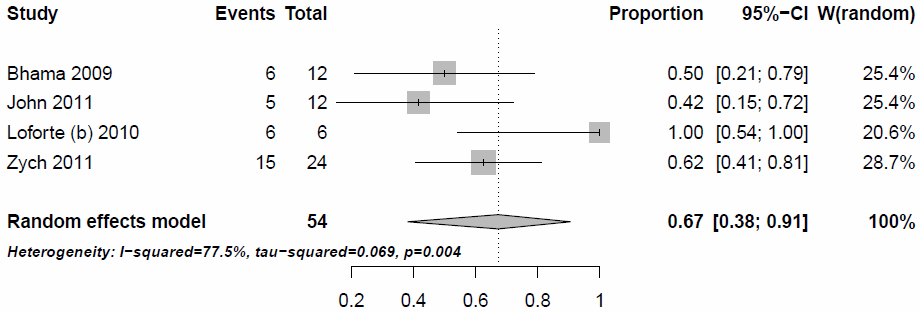


**Figure 39. Survival on support (R-E model)**

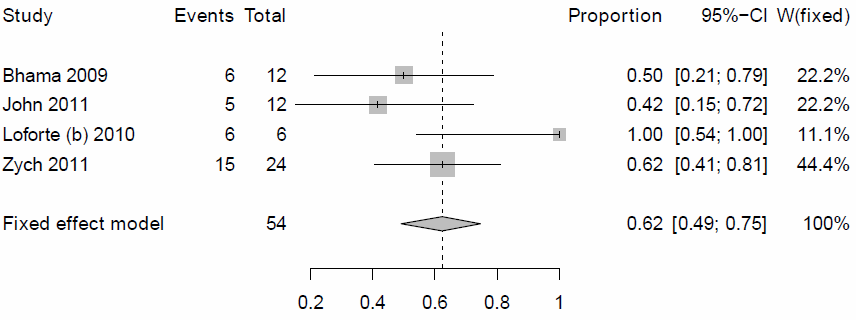


**Figure 40. Survival on support (F-E model)**

**Survival at discharge**

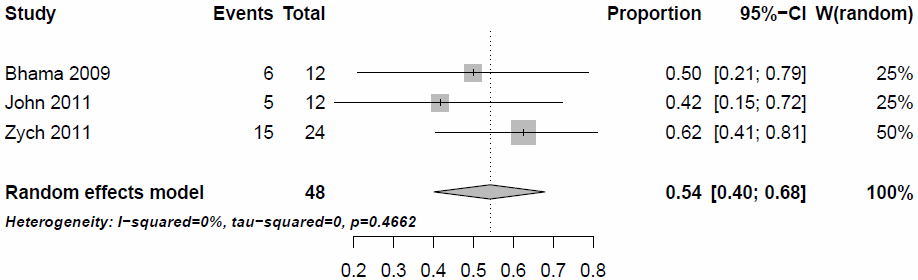


**Figure 41. Survival at discharge (R-E model)**

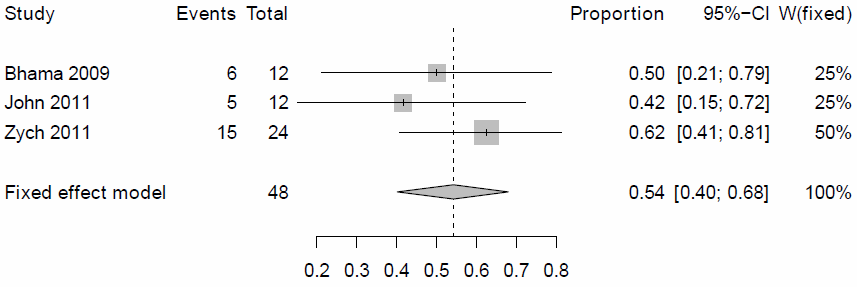


**Figure 42. Survival at discharge (F-E model)**

**Analysis with exclusion of study of Loforte 2010, which contribute the most to heterogeneity of results**

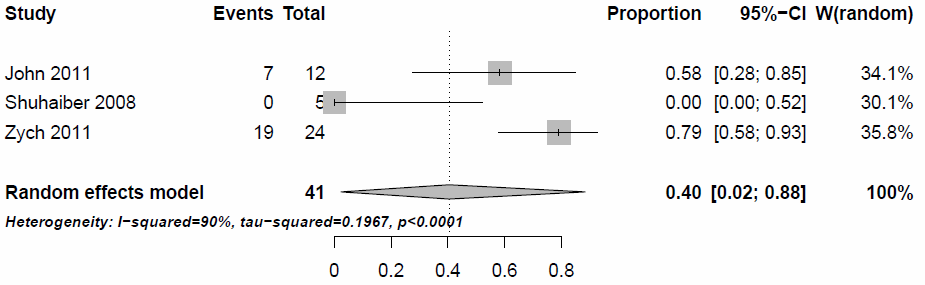


**Figure 43. Survival at discharge (R-E model), Loforte 2010 excluded**

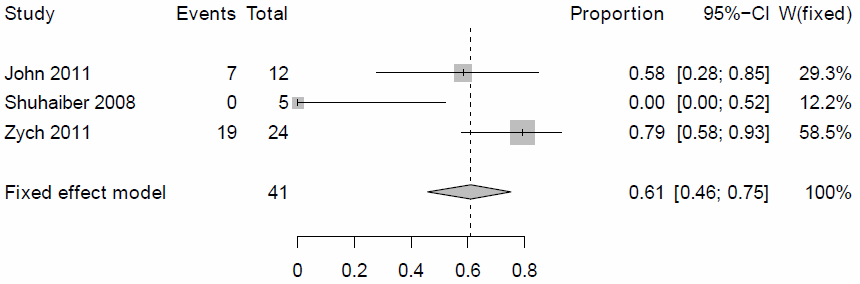


**Figure 44. Survival at discharge (F-E model), Loforte 2010 excluded**

**30-day survival**

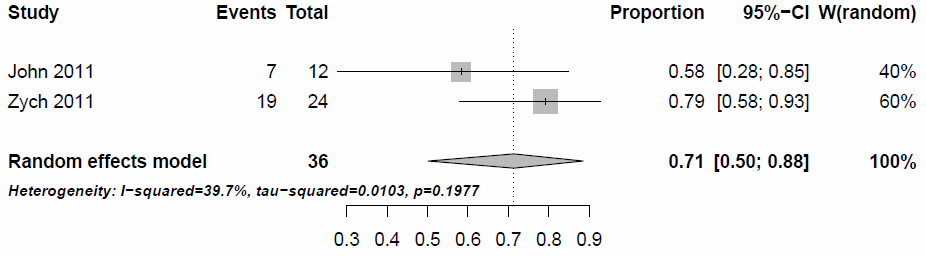


**Figure 45. 30-day survival (R-E model)**

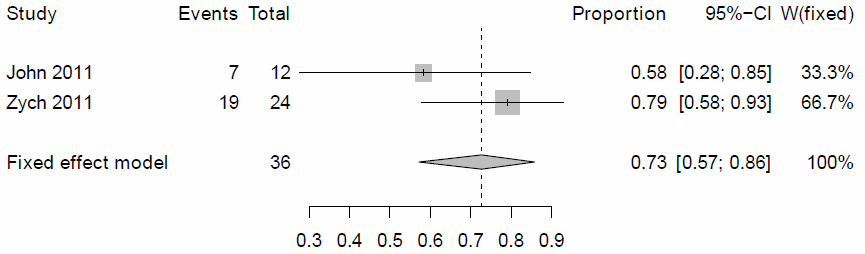


**Figure 46. 30-day survival (F-E model)**

**Analysis with exclusion of study of Shuhaiber 2008, which contribute the most to heterogeneity of results**

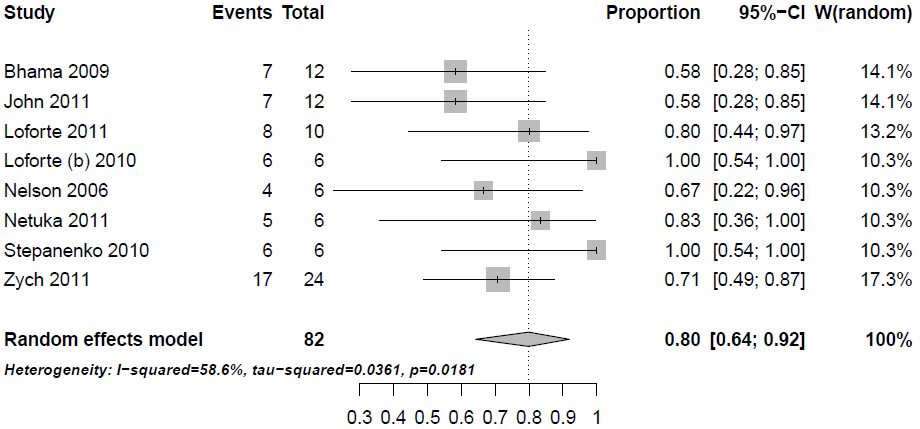


**Figure 47. 30-day survival (R-E model)**

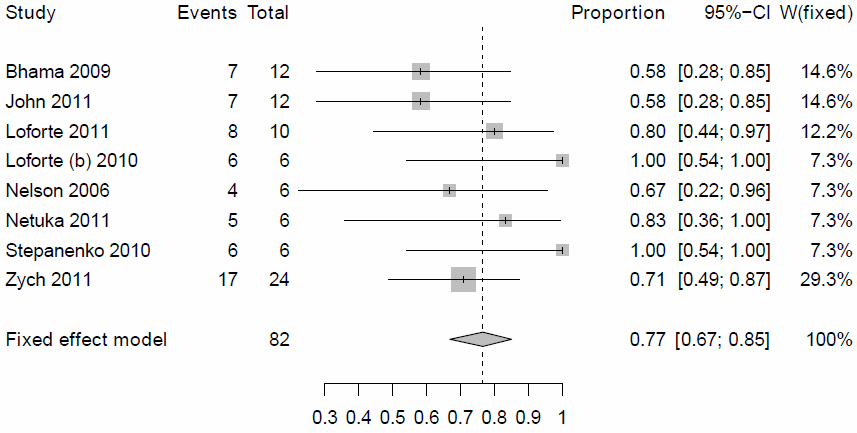


**Figure 48. 30-day survival (F-E model)**

**Weaned from support or bridged to heart transplant or long-term VAD**



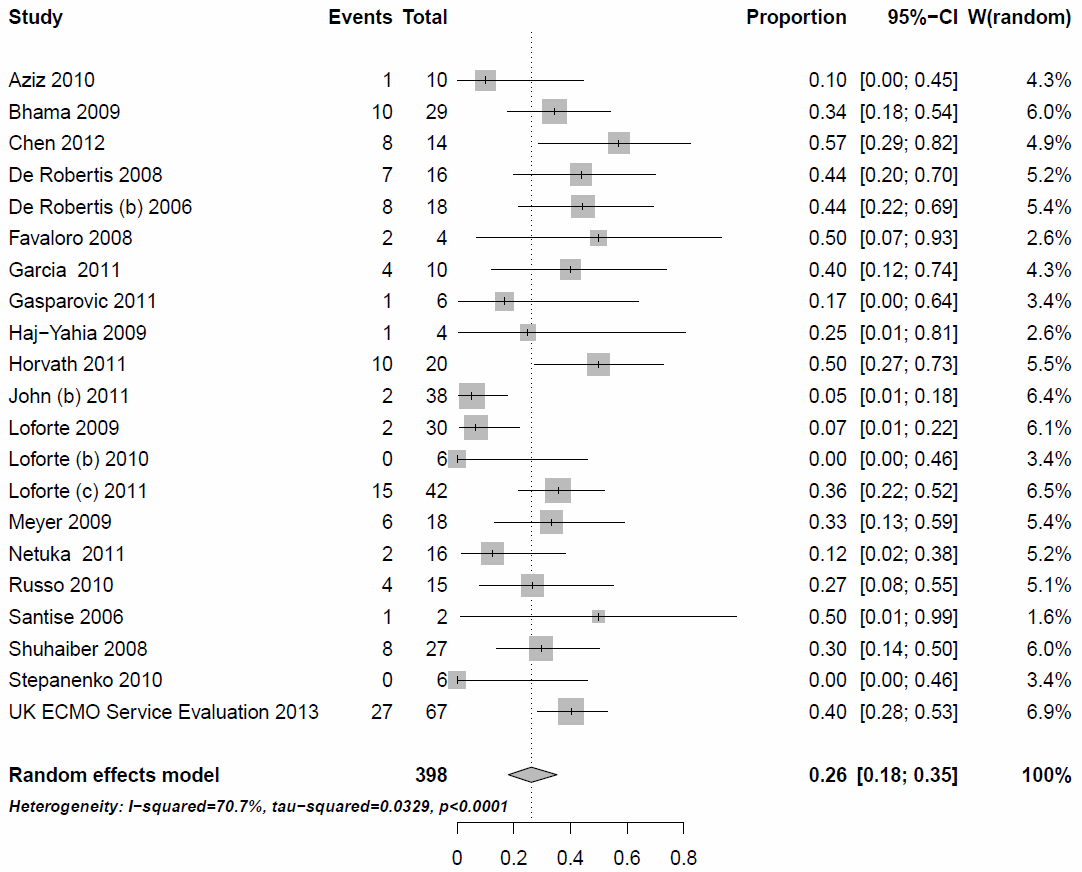
**Figure 49. Weaned from support or bridged to heart transplant or long-term VAD (R-E model)**



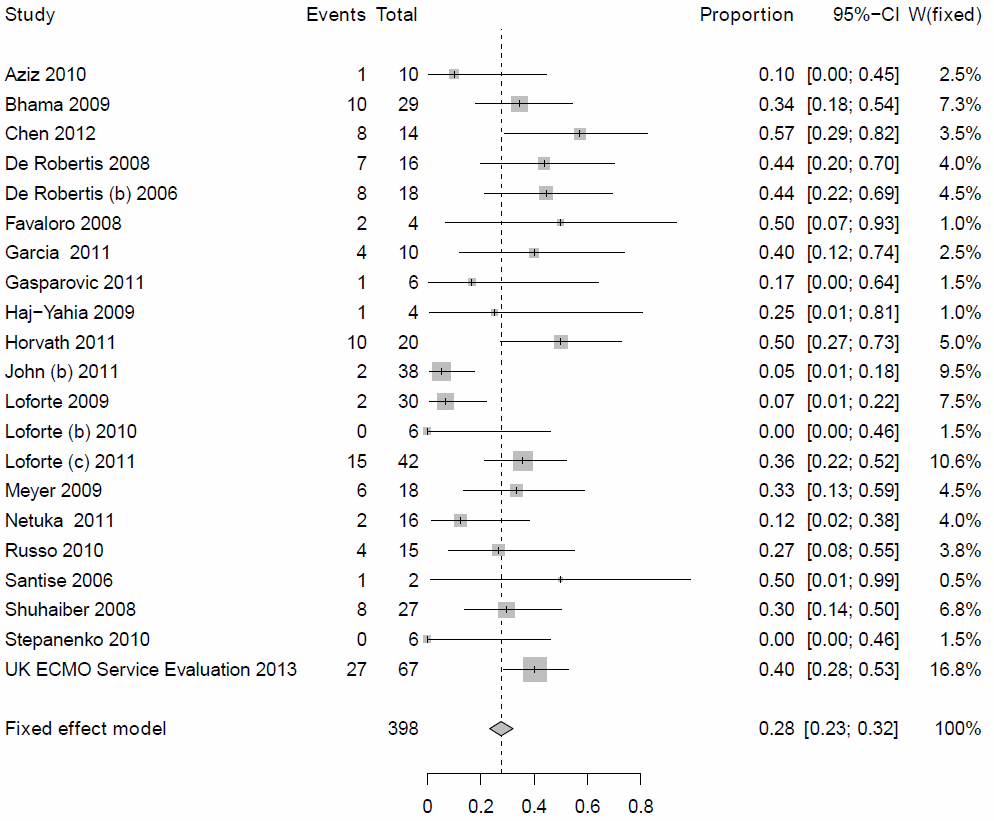
**Figure 50. Weaned from support or bridged to heart transplant or long-term VAD (F-E model)**

## Technical data. Adverse events

**Bleeding**

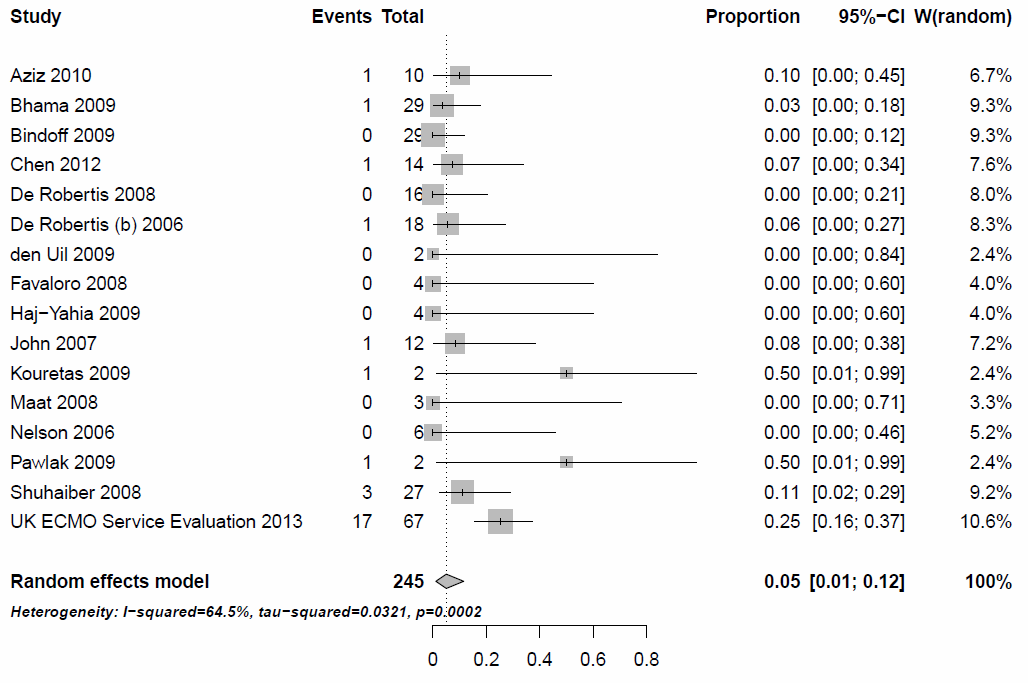


**Figure 51. Proportion of patients, who experienced bleeding (R-E model)**

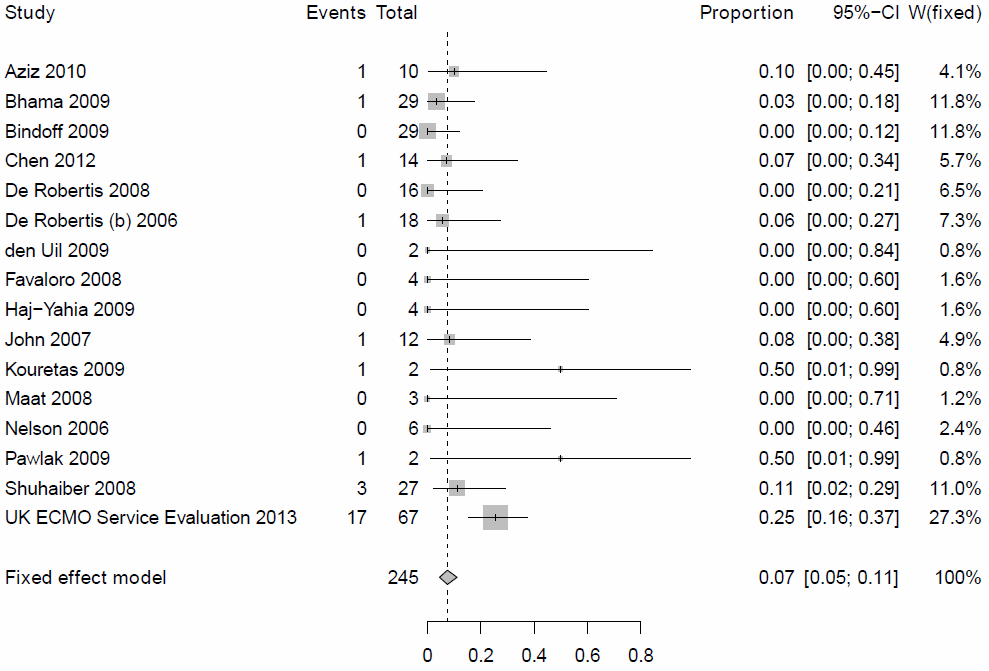


**Figure 52. Proportion of patients, who experienced bleeding (F-E model)**

**Thrombosis and thromboembolism**

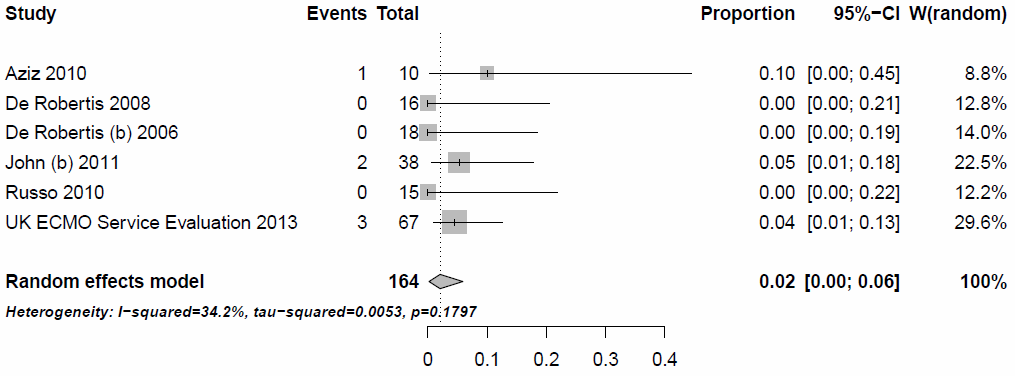


**Figure 53. Proportion of patients, who experienced thrombosis and thromboembolism (R-E model)**

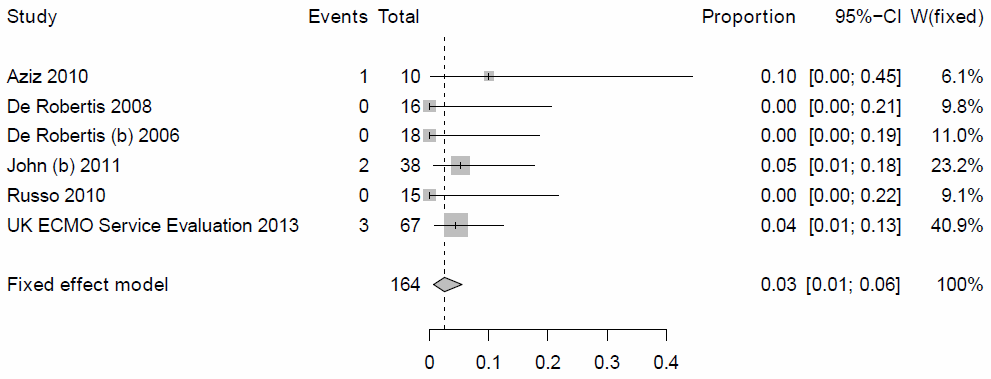


**Figure 54. Proportion of patients, who experienced thrombosis and thromboembolism (F-E model)**

**Hemolysis**

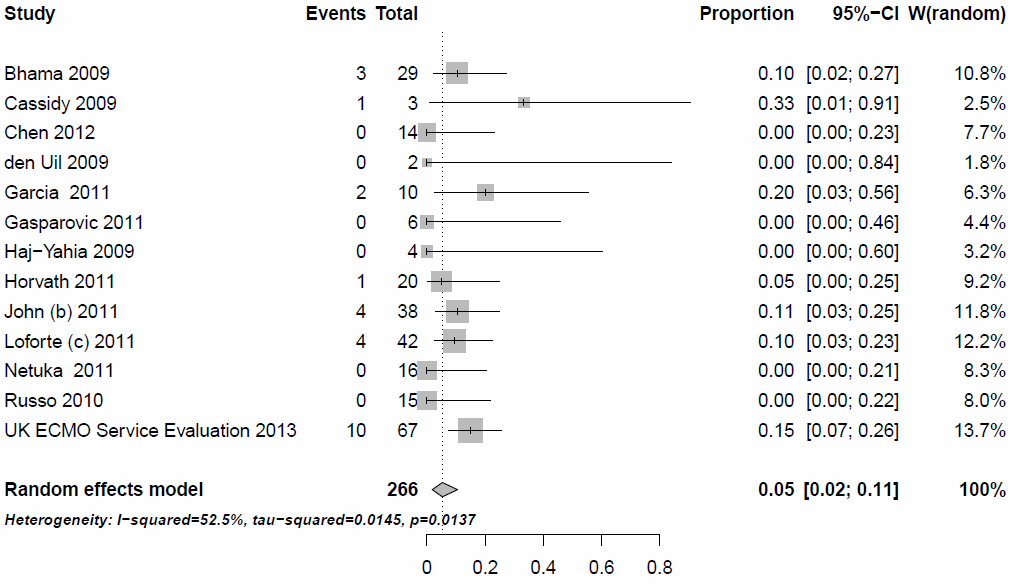


**Figure 55. Proportion of patients, who experienced hemolysis (R-E model)**

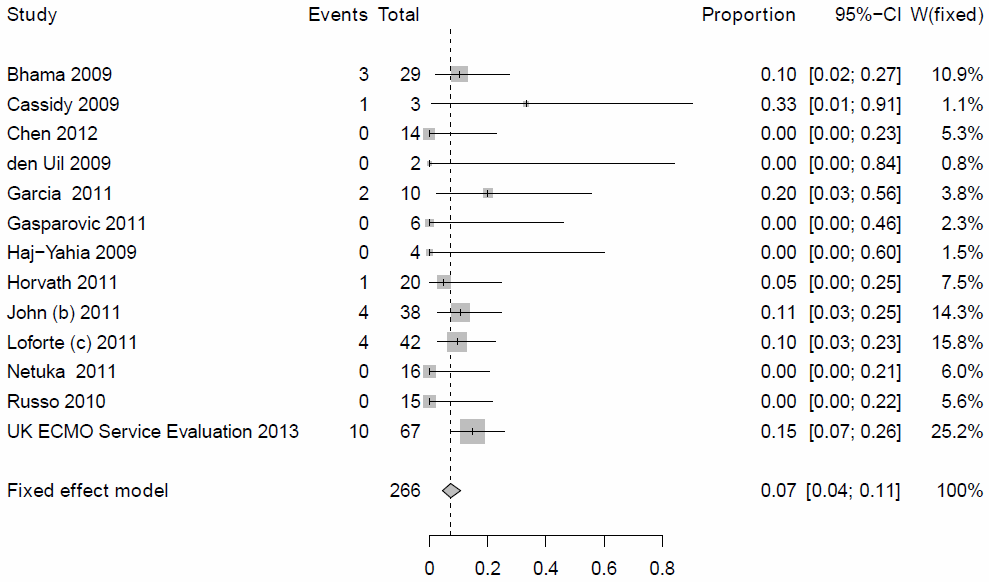


**Figure 56. Proportion of patients, who experienced hemolysis (F-E model)**

**Neurologic complications**

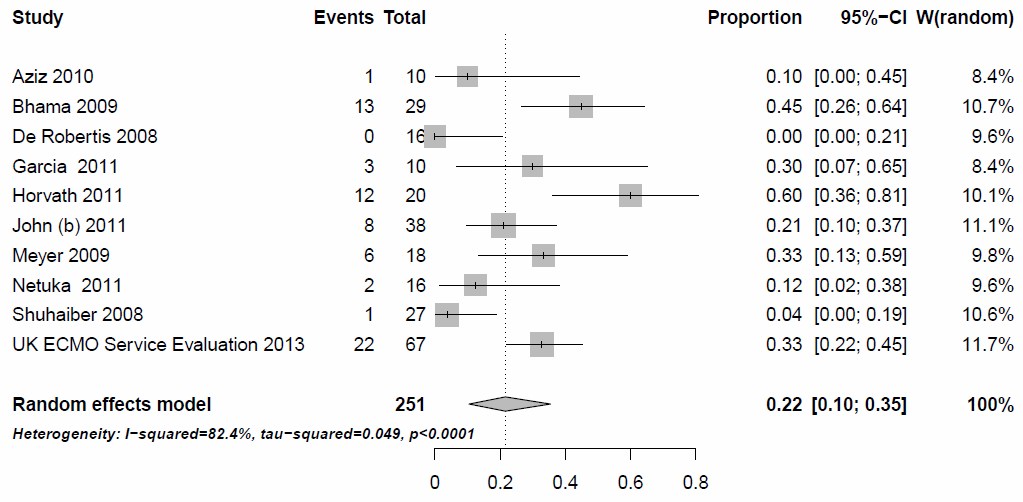


**Figure 57. Proportion of patients, who experienced neurologic complications (R-E model)**

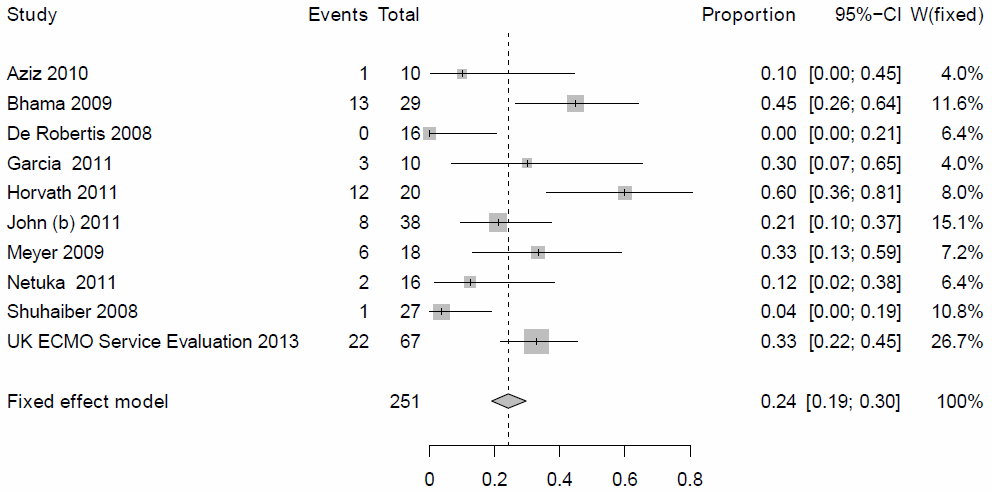


**Figure 58. Proportion of patients, who experienced neurologic complications (F-E model)**

**Infection**

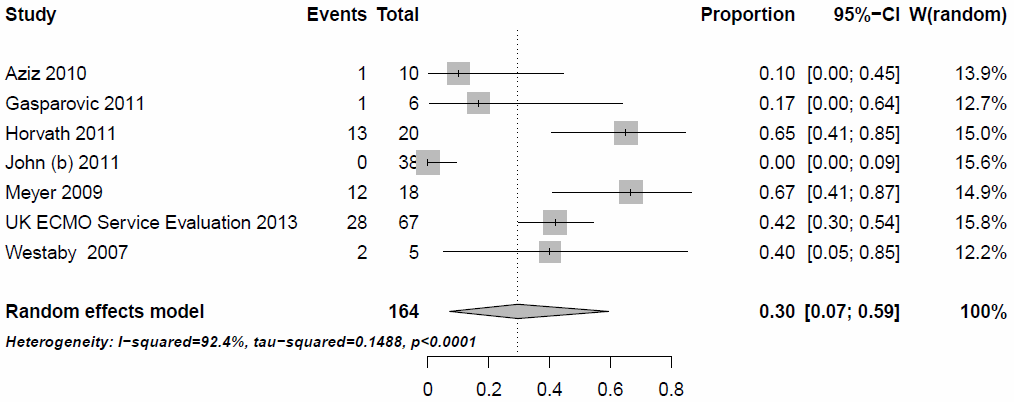


**Figure 59. Proportion of patients, who experienced infection (R-E model)**

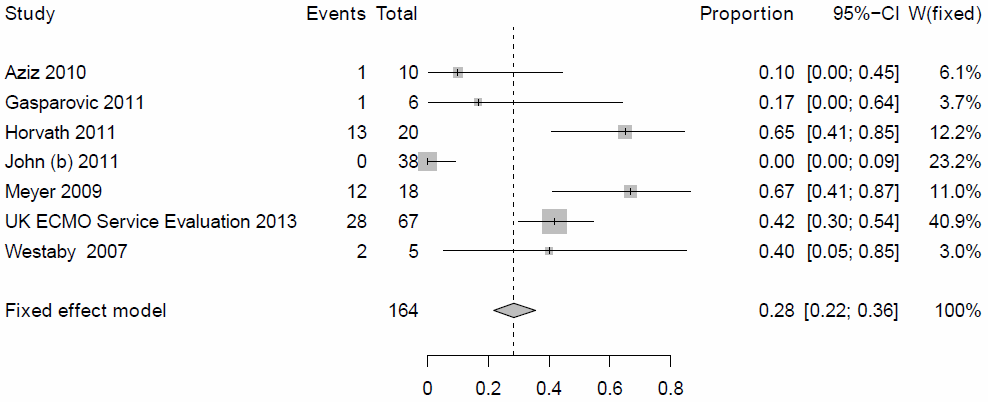


**Figure 60. Proportion of patients, who experienced infection (F-E model)**

**Renal complications**

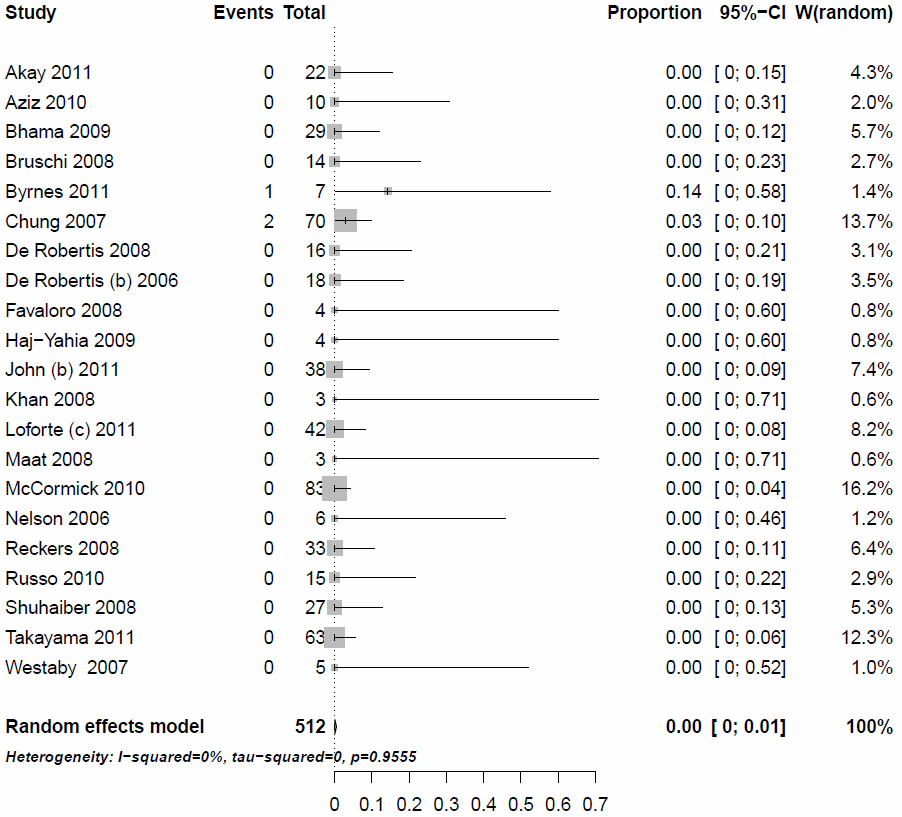


**Figure 61. Proportion of patients, who experienced renal complications (R-E model)**

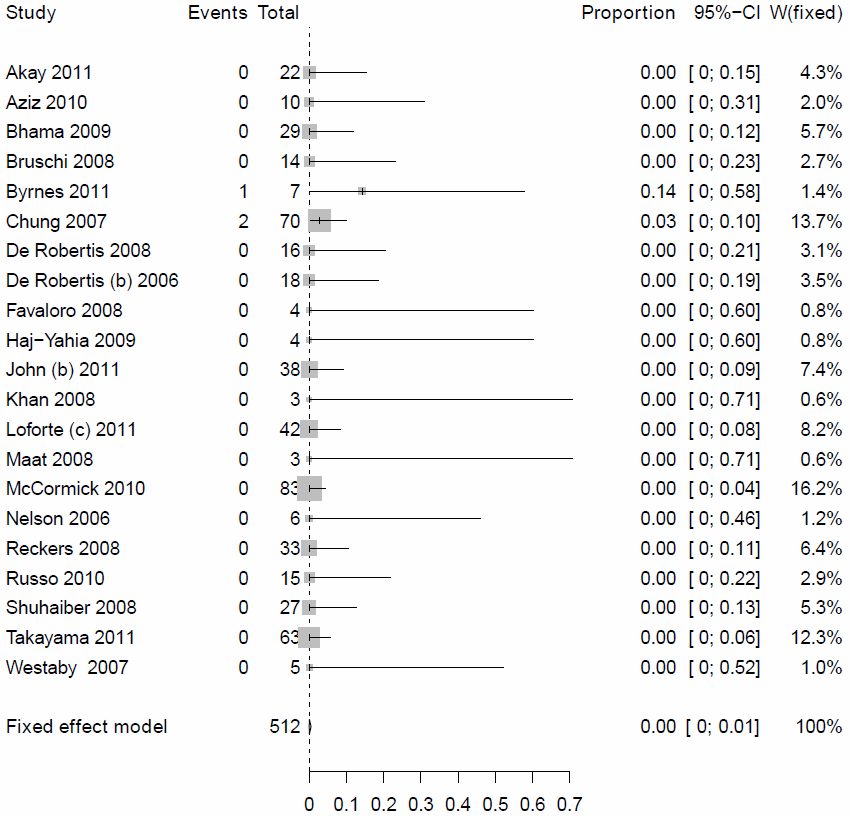


**Figure 62. Proportion of patients, who experienced renal complications (F-E model)**

**Device failure**

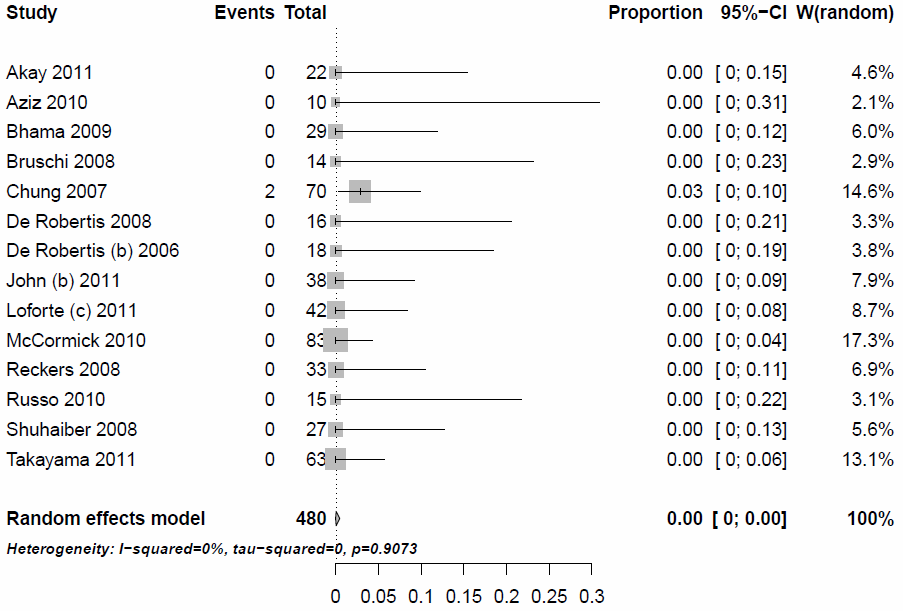


**Figure 63. Proportion of patients, who experienced device failure (R-E model)**

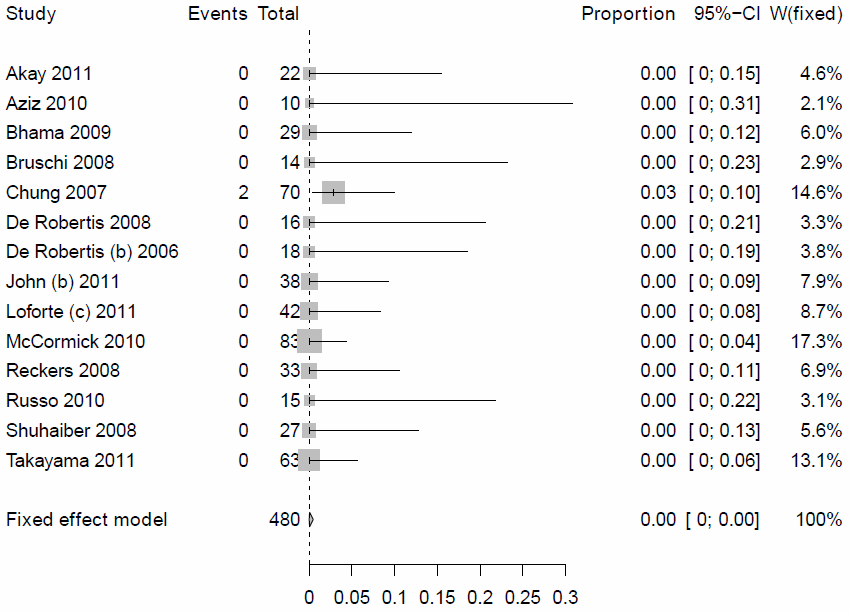


**Figure 64. Proportion of patients, who experienced device failure (F-E model)**

**Analysis of the rate of device failure with exclusion of studies with less than 10 patients included**



**Figure 65. Proportion of patients, who experienced device failure (R-E model)**

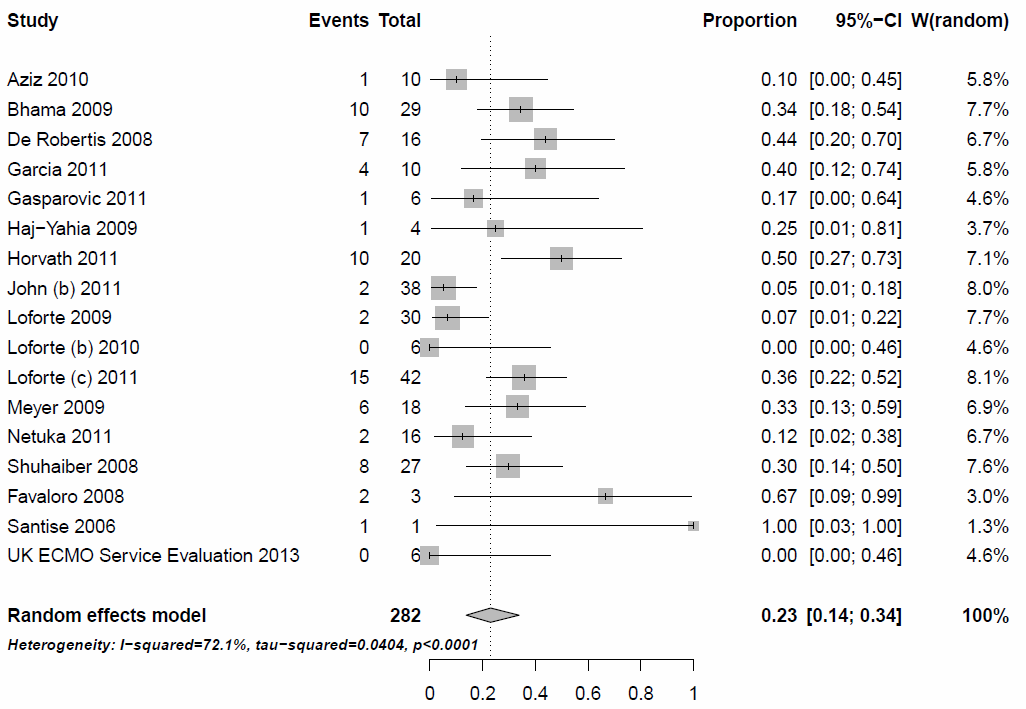


**Figure 66. Proportion of patients, who experienced device failure (F-E model)**

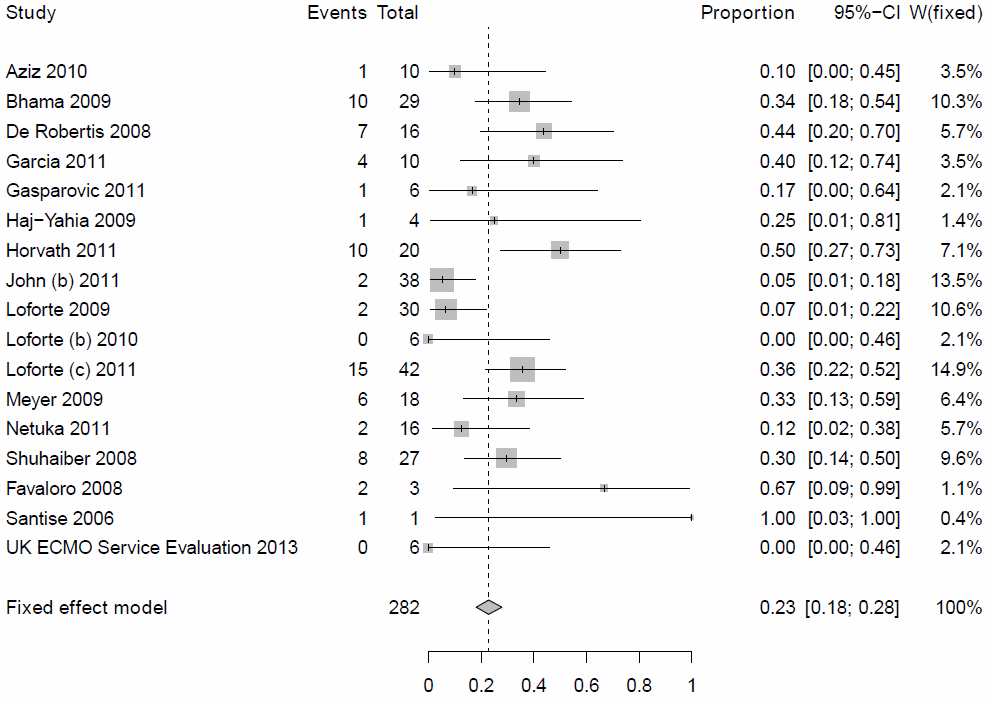
## Technical data. Analysis of adverse events in adult and paediatric populations

**Bleeding**

**Adult population**

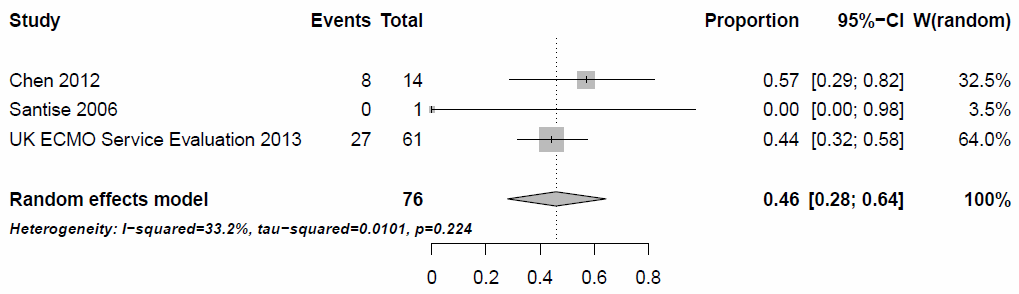


**Figure 67: Proportion of patients, who experienced bleeding (R-E model)**

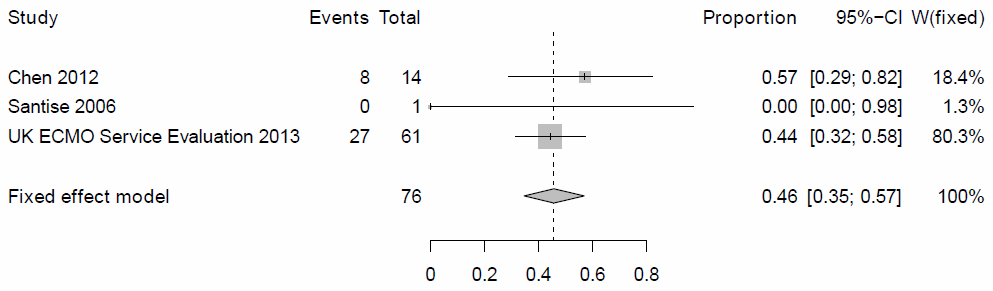


**Figure 68. Proportion of patients, who experienced bleeding (F-E model)**

**Paediatric population**



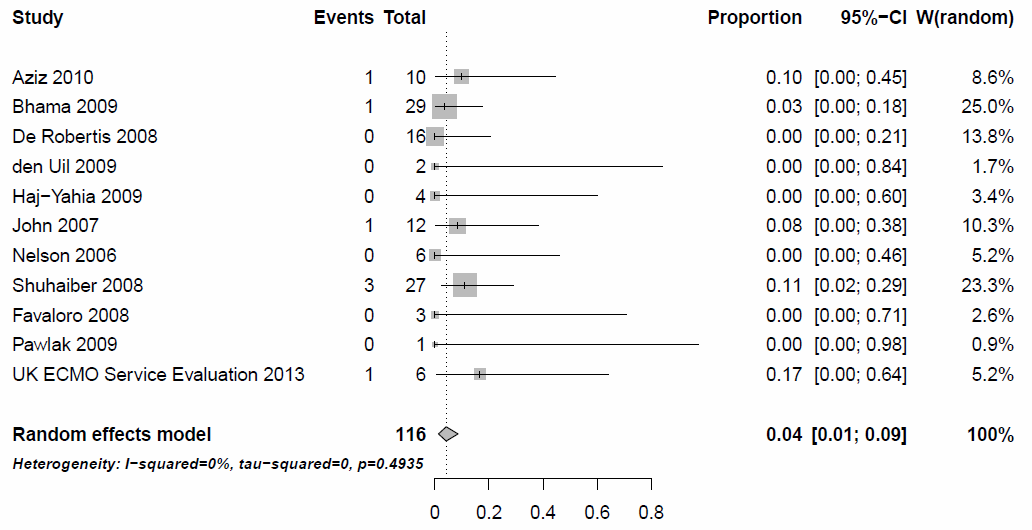
**Figure 69. Proportion of patients, who experienced bleeding (R-E model)**



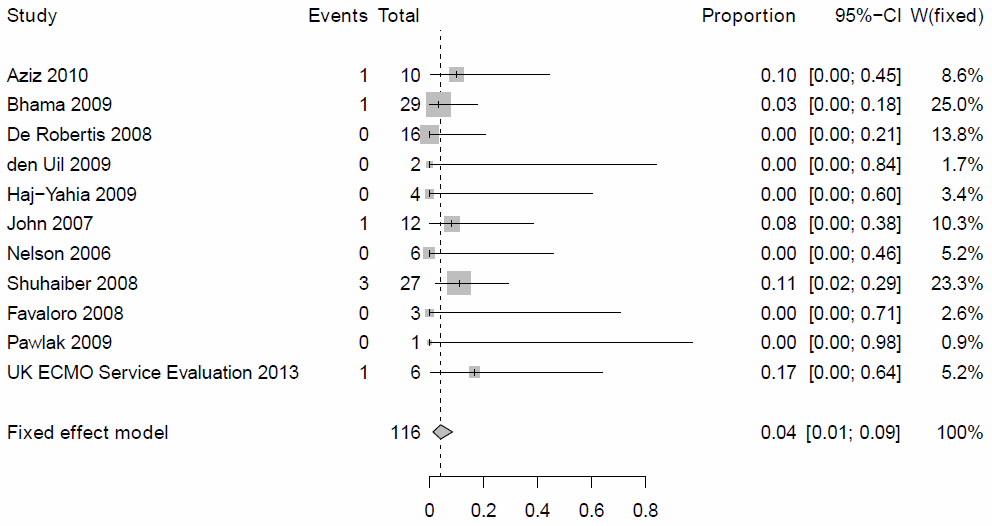
**Figure 70. Proportion of patients, who experienced bleeding (F-E model)**

**Thrombosis and thromboembolism**

**Adult population**

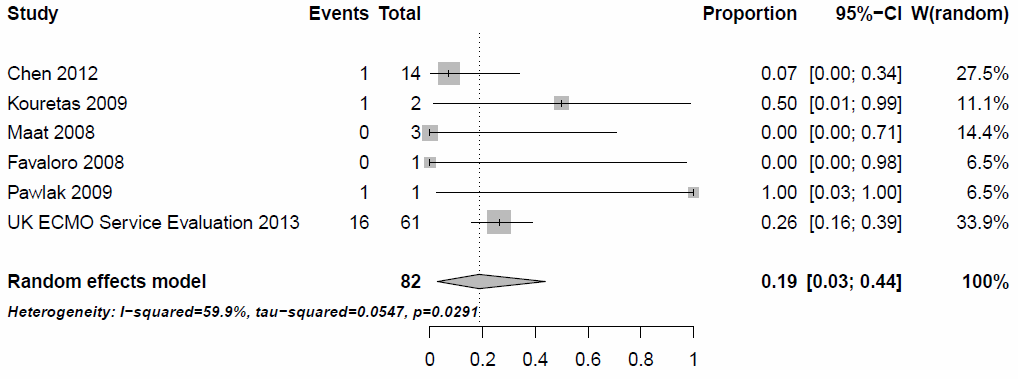


**Figure 71. Proportion of patients, who experienced thrombosis and thromboembolism (R-E model)**

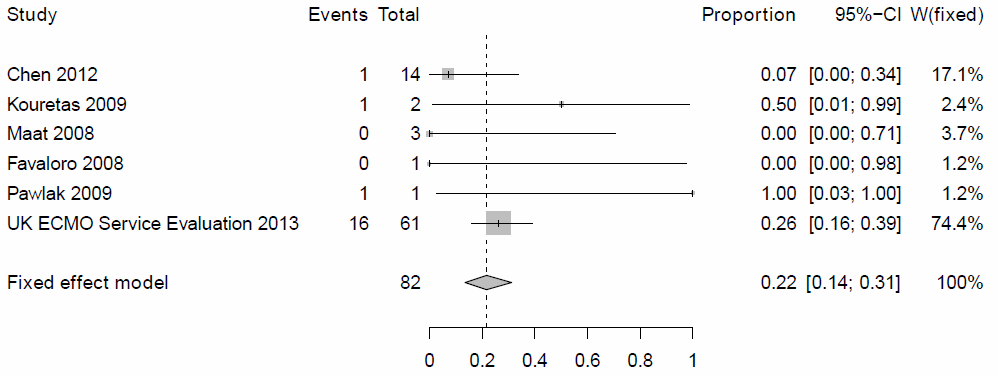


**Figure 72. Proportion of patients, who experienced thrombosis and thromboembolism (F-E model)**

**Paediatric population**



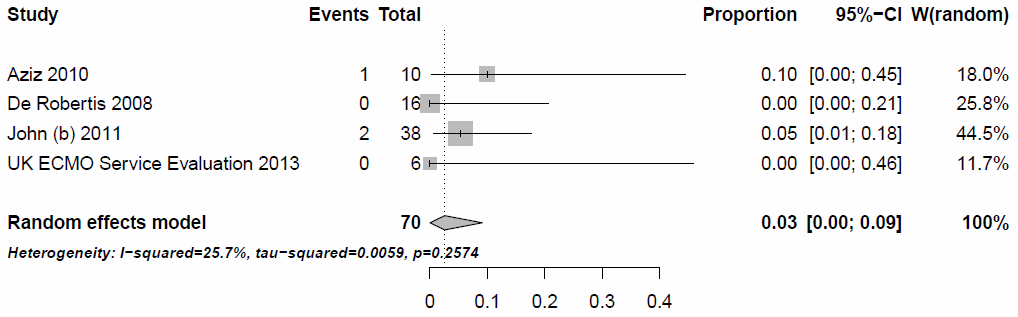
**Figure 73. Proportion of patients, who experienced thrombosis and thromboembolism (R-E model)**

****

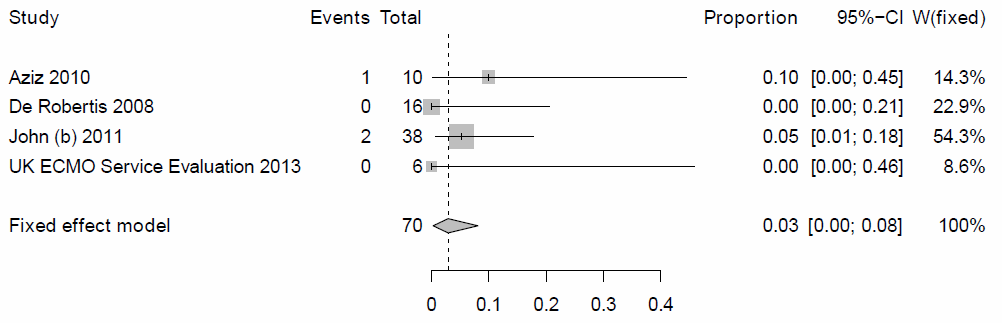
**Figure 74. Proportion of patients, who experienced thrombosis and thromboembolism (F-E model)**

**Hemolysis**

**Adult population**



**Figure 75. Proportion of patients, who experienced hemolysis (R-E model)**



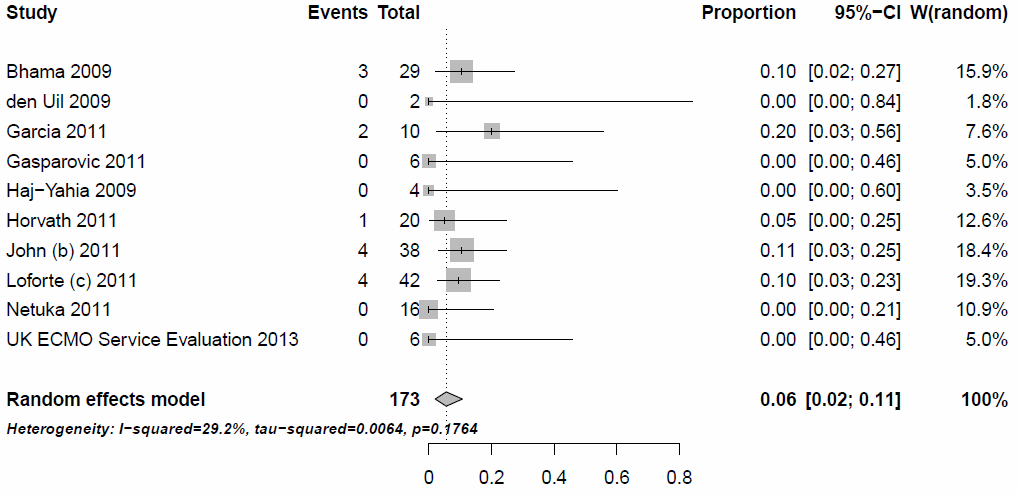
**Figure 76. Proportion of patients, who experienced hemolysis (F-E model)**

**Paediatric population**

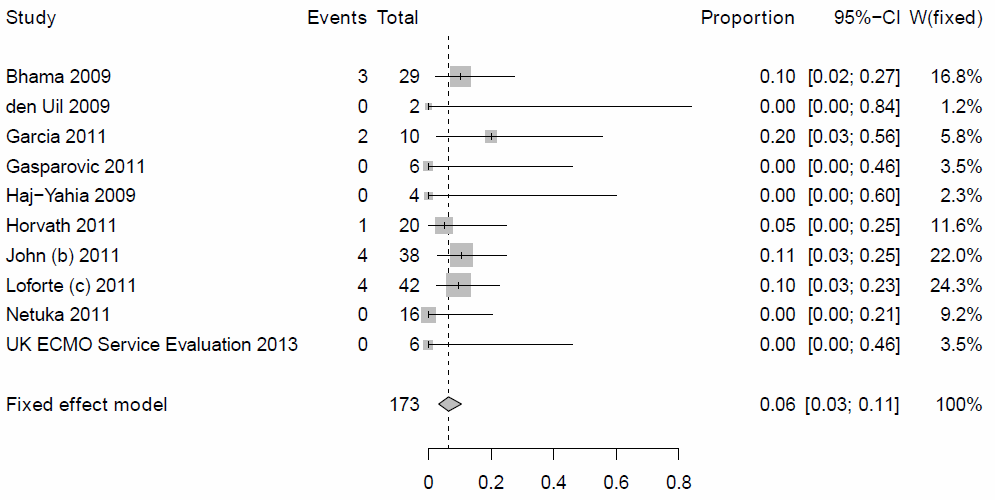
|  |  |  |
| --- | --- | --- |
| **Study** | **N studies (n)** | **Adverse event rate (95% confidence interval)** |
| UK ECMO Service Evaluation 2013 | 61(3) | 0.05 (0.01- 0.14) |

**Neurologic complications**

**Adult population**

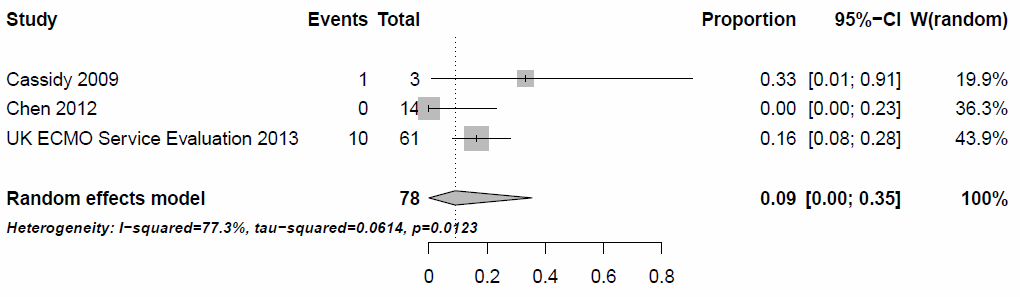


**Figure 77. Proportion of patients, who experienced neurologic complications (R-E model)**

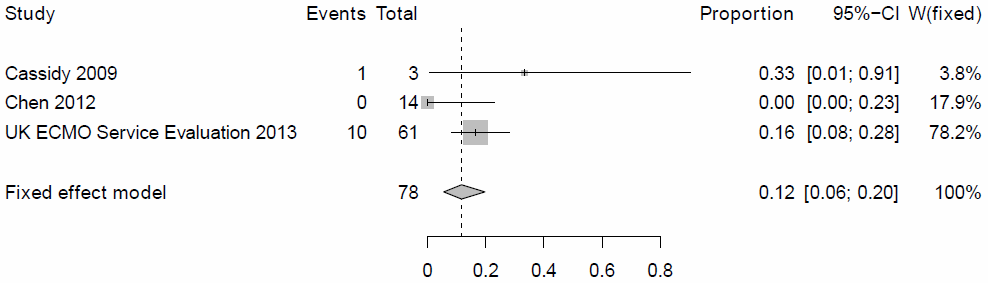


**Figure 78. Proportion of patients, who experienced neurologic complications (F-E model)**

**Paediatric population**



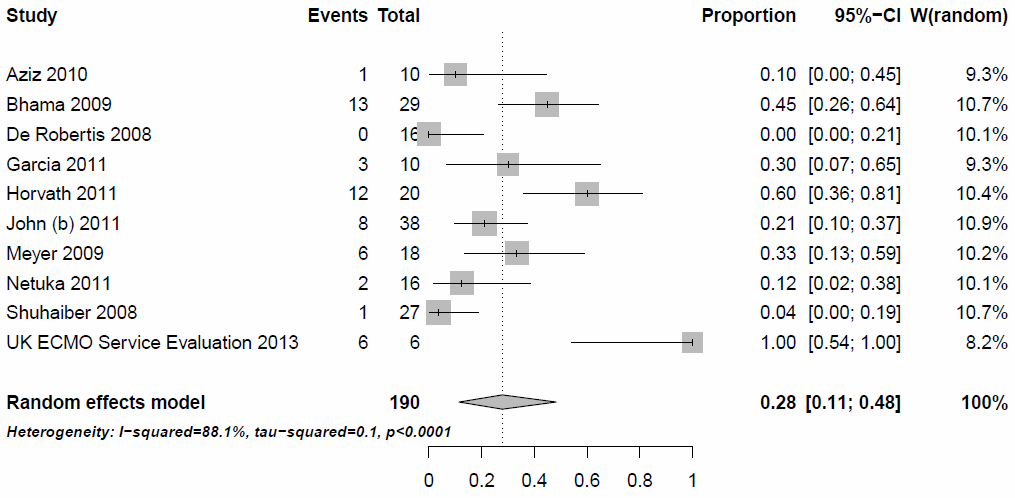
**Figure 79. Proportion of patients, who experienced neurologic complications (R-E model)**



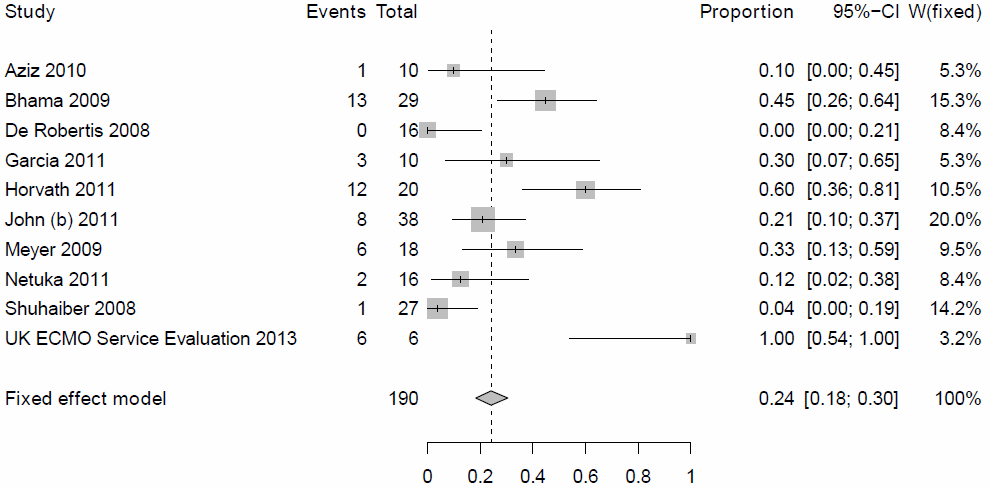
**Figure 80. Proportion of patients, who experienced neurologic complications (F-E model)**

**Infection**

**Adult population**



**Figure 81. Proportion of patients, who experienced infection (R-E model)**



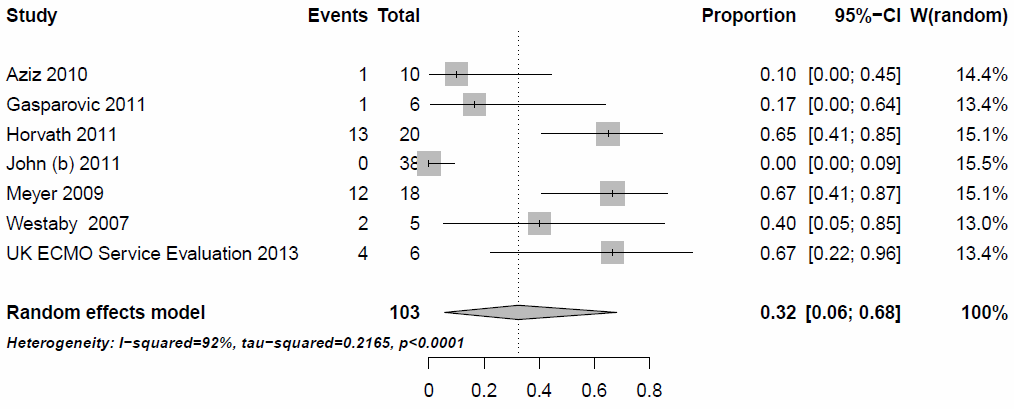
**Figure 82. Proportion of patients, who experienced infection (F-E model)**

**Paediatric population**

|  |  |  |
| --- | --- | --- |
| **Study** | **N studies (n)** | **Adverse event rate (95% confidence interval)** |
| UK ECMO Service Evaluation 2013 | 61(16) | 0.26 (0.16- 0.39) |

**Renal complications**

**Adult population**



**Figure 83. Proportion of patients, who experienced renal complications (R-E model)**



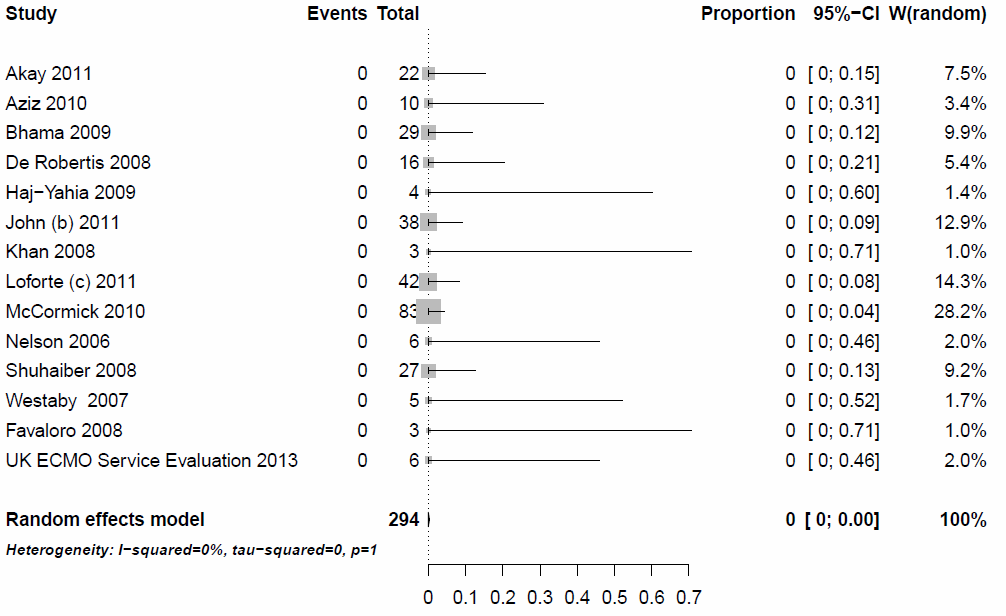
**Figure 84. Proportion of patients, who experienced renal complications (F-E model)**

**Paediatric population**

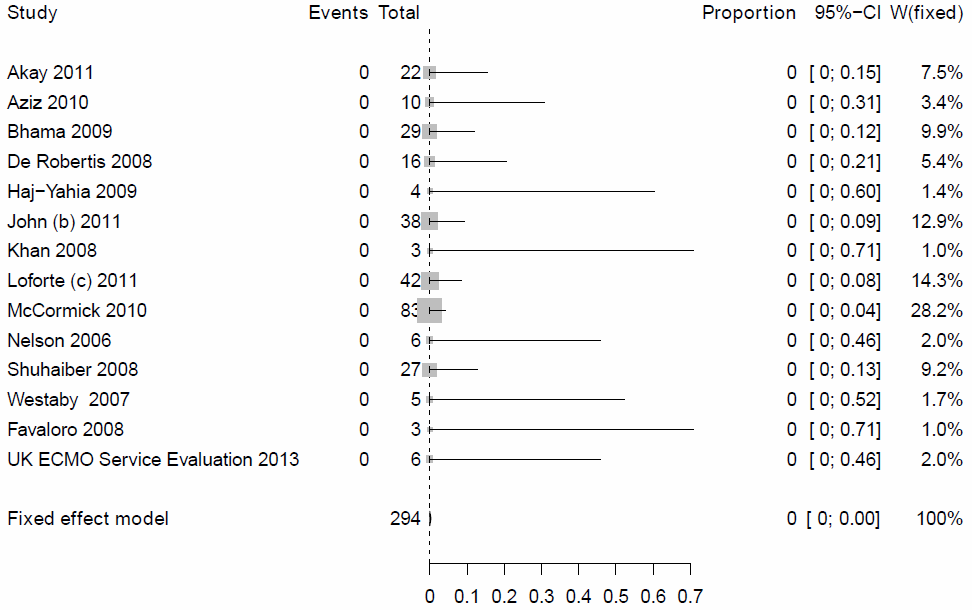
|  |  |  |
| --- | --- | --- |
| **Study** | **N studies (n)** | **Adverse event rate (95% confidence interval)** |
| UK ECMO Service Evaluation 2013 | 61(24) | 0.39 (0.27- 0.53) |

**Device failure**

**Adult population**

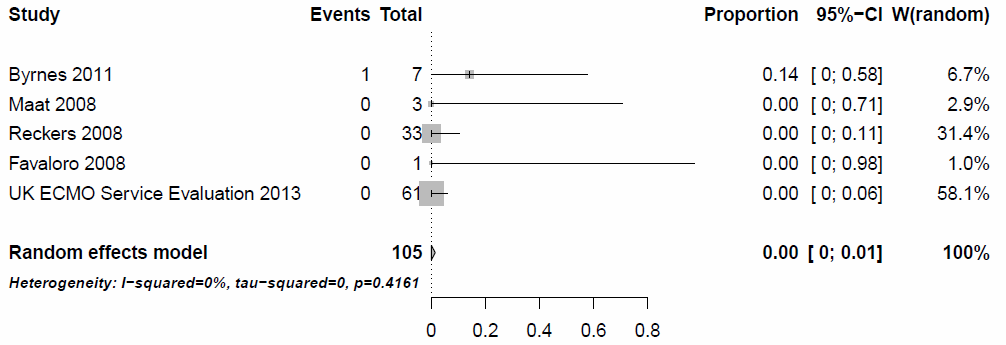


**Figure 85. Proportion of patients, who experienced device failure (R-E model)**

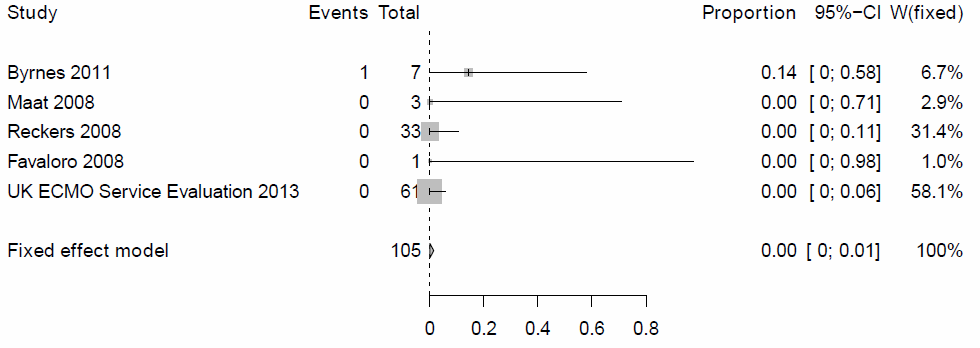


**Figure 86. Proportion of patients, who experienced device failure (F-E model)**

**Paediatric population**



**Figure 87. Proportion of patients, who experienced device failure (R-E model)**



**Figure 88. Proportion of patients, who experienced device failure (F-E model)**

## Additional references

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## R-code for meta-analysis of effectiveness and safety outcomes

install.packages("meta")

library(meta)

#metaprop #function details

#VAD Precardiotomy

surv\_support1<-metaprop(c(13,10,1,2,9),c(16,12,5,3,9),c("De Robertis 2008","John 2007","Loforte (b) 2011","Maat 2008","Morgan 2009"), sm="PAS", comb.fixed=F, comb.random=T

print(surv\_support1)

forest(surv\_support1)

surv\_support1\_NEW<-metaprop(c(13,10,2,9),c(16,12,3,9),c("De Robertis 2008","John 2007","Maat 2008","Morgan 2009"), sm="PAS", comb.fixed=F, comb.random=T)

print(surv\_support1\_NEW)

forest(surv\_support1\_NEW)

surv\_discharge1<-metaprop(c(3,4,7),c(5,4,14),c("Gasparovic 2011","Haj-Yahia 2009","John (b) 2011"), sm="PAS", comb.fixed=F, comb.random=T) #comb.fixed=FALSE, comb.random=TRUE

print(surv\_discharge1)

forest(surv\_discharge1)

surv30\_days1<-metaprop(c(13,4,9,7,9,2),c(16,4,12,14,14,9),c("De Robertis 2008","Haj-Yahia 2009","John 2007","John (b) 2011","Loforte 2009","Shuhaiber 2008"), sm="PAS", comb.fixed=F, comb.random=T)

print(surv30\_days1)

forest(surv30\_days1)

surv30\_days1\_NEW<-metaprop(c(13,4,9,7,9),c(16,4,12,14,14),c("De Robertis 2008","Haj-Yahia 2009","John 2007","John (b) 2011","Loforte 2009"), sm="PAS", comb.fixed=T, comb.random=F)

print(surv30\_days1\_NEW)

forest(surv30\_days1\_NEW)

surv90\_days1<-metaprop(c(11,4,5),c(16,4,9),c("De Robertis ","Haj-Yahia 2T009","Morgan 2009"), sm="PAS",comb.fixed=T, comb.random=F)

print(surv90\_days1)

forest(surv90\_days1)

surv6\_months1<-metaprop(c(11,4,9,6),c(16,4,12,14),c("De Robertis 2008","Haj-Yahia 2009","John 2007","John(b) 2011"), sm="PAS",comb.fixed=F, comb.random=T)

print(surv6\_months1)

forest(surv6\_months1)

surv1\_year1<-metaprop(c(11,4,7),c(16,4,12),c("De Robertis 2008","Haj-Yahia 2009","John 2007"), sm="PAS",comb.fixed=T, comb.random=F)

print(surv1\_year1)

forest(surv1\_year1)

#survPost1\_year1<-metaprop(c(4),c(4),c("Haj-Yahia"), sm="PAS")

weaned1<-metaprop(c(2,2,7),c(16,12,9),c("De Robertis","John","Morgan"), sm="PAS")

Bridged\_HTx1<-metaprop(c(3,3,4,1),c(16,5,4,5),c("De Robertis","Gasparovic","Haj-Yahia","Loforte (b)"), sm="PAS")

Bridged\_VAD1<-metaprop(c(6,8,2,2),c(16,12,3,9),c("De Robertis","Gasparovic","Haj-Yahia","Loforte (b)"), sm="PAS")

#VAD Post\_CSCS

surv\_support2<-metaprop(c(2,12,2,3,4),c(2,23,2,5,5),c("Clough 2009","Loforte (b) 2011","Marquez 2009","Netuka 2011","Westaby 2007"), sm="PAS",comb.fixed=T, comb.random=F)

print(surv\_support2)

forest(surv\_support2)

surv\_discharge2<-metaprop(c(3,2,0,4,2,5,4),c(7,2,1,12,2,8,5),c("Bhama 2009","Clough 2009","Gasparovic 2011","John 2011","Marquez 2009","McCormick 2010","Westaby 2007"), sm="PAS",comb.fixed=F, comb.random=T)

print(surv\_discharge2)

forest(surv\_discharge2)

surv30\_days2<-metaprop(c(9,4,6,5,3),c(22,12,16,8,7),c("Akay 2011","John 2011","Loforte 2009","McCormick 2010","Shuhaiber 2008"), sm="PAS",comb.fixed=F, comb.random=T)

print(surv30\_days2)

forest(surv30\_days2)

surv90\_days2 #no data

surv6\_months2<-metaprop(c(2,5),c(12,8),c("John 2011","McCormick 2010"), sm="PAS",comb.fixed=F, comb.random=T)

print(surv6\_months2)

forest(surv6\_months2)

surv1\_year2<-metaprop(c(5),c(8),c("McCormick 2010"), sm="PAS")

survPost1\_year2 #no data

weaned2<-metaprop(c(9,3,2,11,1,3,4),c(22,7,2,23,2,5,5),c("Akay 2011","Bhama 2009","Clough 2009","Loforte (b) 2011","Marquez 2009","Netuka 2011","Westaby 2007"), sm="PAS")

Bridged\_HTx2<-metaprop(c(1),c(23),c("Loforte (b)"), sm="PAS")

Bridged\_VAD2<-metaprop(c(1),c(2),c("Marquez"), sm="PAS")

#VAD Post\_transplant

surv\_support3<-metaprop(c(4,2,17),c(4,2,34),c("Loforte 2011","Santise 2006","Thomas 2011"), sm="PAS",comb.fixed=F, comb.random=T)

print(surv\_support3)

forest(surv\_support3)

surv\_discharge3<-metaprop(c(6,2),c(10,2),c("Bhama 2009","Santise 2006"), sm="PAS",comb.fixed=T, comb.random=F)

print(surv\_discharge3)

forest(surv\_discharge3)

surv30\_days3<-metaprop(c(4,3,17),c(5,6,34),c("Netuka 2011","Shuhaiber 2008","Thomas 2011"), sm="PAS",comb.fixed=T, comb.random=F)

print(surv30\_days3)

forest(surv30\_days3)

surv90\_days3 #no data

surv6\_months3 #no data

surv1\_year3<-metaprop(c(11),c(34),c("Thomas"), sm="PAS",comb.fixed=F, comb.random=T)

survPost1\_year3 #no data

#weaned3<-metaprop(c(7,4,4,1,12),c(10,4,5,2,34),c("Bhama","Loforte","Netuka","Santise","Thomas"), sm="PAS")

#Bridged\_HTx3<-metaprop(c(1,5),c(2,34),c("Santise","Thomas"), sm="PAS")

#Bridged\_VAD3 #no data

Weaned\_bridged<-metaprop(c(7,4,4,2,17),c(10,4,5,2,34),c("Bhama 2009","Loforte 2011","Netuka 2011","Santise 2006","Thomas 2011"), sm="PAS",comb.fixed=T, comb.random=F)

print(Weaned\_bridged)

forest(Weaned\_bridged)

#VAD Post\_LVAD

surv\_support3<-metaprop(c(8,6,4,5,6,17),c(10,6,6,6,6,24),c("Loforte 2011","Loforte (b) 2010","Nelson 2006","Netuka 2011","Stepanenko 2010","Zych 2011"), sm="PAS",comb.fixed=T, comb.random=F)

print(surv\_support3)

forest(surv\_support3)

surv\_discharge3<-metaprop(c(6,5,6,15),c(12,12,6,24),c("Bhama 2009","John 2011","Loforte (b) 2010","Zych 2011"), sm="PAS",comb.fixed=F, comb.random=T)

print(surv\_discharge3)

forest(surv\_discharge3)

surv\_discharge3\_NEW<-metaprop(c(6,5,15),c(12,12,24),c("Bhama 2009","John 2011","Zych 2011"), sm="PAS",comb.fixed=T, comb.random=F)

print(surv\_discharge3\_NEW)

forest(surv\_discharge3\_NEW)

surv30\_days3<-metaprop(c(7,0,19),c(12,5,24),c("John 2011","Shuhaiber 2008","Zych 2011"), sm="PAS",comb.fixed=F, comb.random=T)

print(surv30\_days3)

forest(surv30\_days3)

surv30\_days3\_NEW<-metaprop(c(7,19),c(12,24),c("John 2011","Zych 2011"), sm="PAS",comb.fixed=T, comb.random=F)

print(surv30\_days3\_NEW)

forest(surv30\_days3\_NEW)

surv90\_days3 <-metaprop(c(17),c(24),c("Zych"), sm="PAS",comb.fixed=F, comb.random=T)

surv6\_months3 <-metaprop(c(4),c(12),c("John"), sm="PAS",comb.fixed=F, comb.random=T)

surv1\_year3<-metaprop(c(14),c(24),c("Zych"), sm="PAS",comb.fixed=F, comb.random=T)

survPost1\_year3 #no data

#weaned3<-metaprop(c(7,6,8,6,3,5,6,14),c(12,12,10,6,6,6,6,24),c("Bhama","John","Loforte","Loforte (b)","Nelson","Netuka","Stepanenko","Zych"), sm="PAS")

#Bridged\_HTx3<-metaprop(c(3),c(24),c("Zych"), sm="PAS")

#Bridged\_VAD3<-metaprop(c(1,1),c(12,6),c("John","Nelson"), sm="PAS")

Weaned\_bridged<-metaprop(c(7,7,8,6,4,5,6,17),c(12,12,10,6,6,6,6,24),c("Bhama 2009","John 2011","Loforte 2011","Loforte (b) 2010","Nelson 2006","Netuka 2011","Stepanenko 2010","Zych 2011"), sm="PAS")

print(Weaned\_bridged)

forest(Weaned\_bridged)

#aDVERSE EVENT

Adverse.events <- read.csv("C:/Users/ana.turk/Desktop/Adverse events.csv", sep=";")

head(Adverse.events)

Bleeding<-na.omit(data.frame(Author=Adverse.events$A.Y,Total=Adverse.events$No.Centrimag,Event=Adverse.events$Bleeding.events))

meta\_Bleeding<-metaprop(Bleeding$Event,Bleeding$Total,Bleeding$Author, sm="PAS",comb.fixed=T, comb.random=F)

print(meta\_Bleeding)

forest(meta\_Bleeding)

Thrombosis<-na.omit(data.frame(Author=Adverse.events$A.Y,Total=Adverse.events$No.Centrimag,Event=Adverse.events$Thrombosis.events))

meta\_Thrombosis<-metaprop(Thrombosis$Event,Thrombosis$Total,Thrombosis$Author, sm="PAS",comb.fixed=T, comb.random=F)

print(meta\_Thrombosis)

forest(meta\_Thrombosis)

Hemolysis<-na.omit(data.frame(Author=Adverse.events$A.Y,Total=Adverse.events$No.Centrimag,Event=Adverse.events$Hemolysis.events))

meta\_Hemolysis<-metaprop(Hemolysis$Event,Hemolysis$Total,Hemolysis$Author, sm="PAS",comb.fixed=T, comb.random=F)

print(meta\_Hemolysis)

forest(meta\_Hemolysis)

Neurologic<-na.omit(data.frame(Author=Adverse.events$A.Y,Total=Adverse.events$No.Centrimag,Event=Adverse.events$Neurologic.events))

meta\_Neurologic<-metaprop(Neurologic$Event,Neurologic$Total,Neurologic$Author, sm="PAS",comb.fixed=T, comb.random=F)

print(meta\_Neurologic)

forest(meta\_Neurologic)

Infection<-na.omit(data.frame(Author=Adverse.events$A.Y,Total=Adverse.events$No.Centrimag,Event=Adverse.events$Infection.events))

meta\_Infection<-metaprop(Infection$Event,Infection$Total,Infection$Author, sm="PAS",comb.fixed=T, comb.random=F)

print(meta\_Infection)

forest(meta\_Infection)

Renal<-na.omit(data.frame(Author=Adverse.events$A.Y,Total=Adverse.events$No.Centrimag,Event=Adverse.events$Renal.events))

meta\_Renal<-metaprop(Renal$Event,Renal$Total,Renal$Author, sm="PAS",comb.fixed=T, comb.random=F)

print(meta\_Renal)

forest(meta\_Renal)

Device<-na.omit(data.frame(Author=Adverse.events$A.Y,Total=Adverse.events$No.Centrimag,Event=Adverse.events$Device.events))

meta\_Device<-metaprop(Device$Event,Device$Total,Device$Author, sm="PAS",comb.fixed=T, comb.random=F)

print(meta\_Device)

forest(meta\_Device)

device10 <- read.csv("C:/Users/ana.turk/Desktop/device10.csv", sep=";")

Device2<-metaprop(device10$Device.events,device10$No.Centrimag,device10$A.Y, sm="PAS",comb.fixed=T, comb.random=F)

print(Device2)

forest(Device2)