**Supplementary Materials. Full search strategies**

**PubMed**

**1/25/2018**

781 Results

No limits applied

**8/28/2018**

32 Results

Limited to 1/26/2018-Present

("Catheterization, Central Venous"[Mesh] OR "Central Venous Catheters"[Mesh] OR "central catheter"[tiab] OR "central catheterization"[tiab] OR "central line"[tiab] OR "central venous catheter"[tiab] OR "central venous catheterization"[tiab] OR "central venous line"[tiab] OR "venous cannulation"[tiab] OR "venous access"[tiab] OR "venous catheter"[tiab] OR "venous catheterization"[tiab] OR "vein cannulation"[tiab] OR "vein access"[tiab] OR "vein catheter"[tiab] OR "vein catheterization"[tiab] OR "vascular access device"[tiab] OR portacath[tiab] OR "peripherally inserted central catheter"[tiab] OR groshong[tiab] OR broviac[tiab] OR hickman[tiab]) AND ("Ultrasonography"[Mesh] OR "Ultrasonography, Interventional"[Mesh] OR "Ultrasonics"[Mesh] OR ultrasound[tiab] OR ultrasonic[tiab] OR ultrasonography[tiab] OR "Reminder Systems"[Mesh] OR reminder[tiab]) OR "Quality Improvement"[Mesh] OR intervention[tiab] OR "multicomponent intervention"[tiab] OR "multi-component intervention"[tiab] OR "multidisciplinary intervention"[tiab] OR "multi-disciplinary intervention"[tiab] OR "multifaceted intervention"[tiab] OR "multi-faceted intervention"[tiab] OR "multimodal intervention"[tiab] OR "multi-modal intervention"[tiab] OR pre-intervention[tiab] OR preintervention[tiab] OR pre intervention[tiab] OR post-intervention[tiab] OR postintervention[tiab] OR post intervention[tiab] OR pre-post[tiab] OR pre test[tiab] OR pretest[tiab] OR posttest[tiab] OR post test[tiab] OR "quality improving"[tiab] OR "quality improvement"[tiab] OR "quality management"[tiab] OR "quality care"[tiab] OR "quality healthcare"[tiab]) AND ("Device Removal"[Mesh] OR (Remov\*[tiab] OR Inappropriate\*[tiab] OR appropriate\*[tiab]) OR unnecessary[tiab] OR idle[tiab] OR unuse\*[tiab] OR unjustif\*[tiab] OR adequacy[tiabt] OR redundant[tiab]

**EMBASE**

**1/31/2018**

1373 Results

No limits applied

**8/28/2018**

127 Results

Limited to 2/1/2018-Present

#1 'central venous catheterization'/exp

#2 'central venous catheter'/exp

#3 'central catheter':ab,ti OR 'central catheterization':ab,ti OR 'central line':ab,ti OR 'central venous catheter':ab,ti OR 'central venous catheterization':ab,ti OR 'central venous line':ab,ti OR 'venous cannulation':ab,ti OR 'venous access':ab,ti OR 'venous catheter':ab,ti OR 'venous catheterization':ab,ti OR 'vein cannulation':ab,ti OR 'vein access':ab,ti OR 'vein catheter':ab,ti OR 'vein catheterization':ab,ti OR 'vascular access device':ab,ti OR 'portacath':ab,ti OR 'peripherally inserted central catheter':ab,ti OR 'groshong':ab,ti OR 'broviac':ab,ti OR 'hickman':ab,ti

#4 #1 OR #2 OR #3

#5 'intravascular ultrasound'/exp

#6 'intravascular ultrasound system'/exp

#7 'ultrasound':ab,ti OR 'ultrasonic':ab,ti OR 'ultrasonography':ab,ti

#8 #5 OR #6 OR #7

#9 'reminder system'/exp

#10 'reminder':ab,ti

#11 #9 OR #10

#12 'total quality management'/exp

#13 'intervention':ab,ti OR 'preintervention':ab,ti OR 'pre intervention':ab,ti OR 'pre-intervention':ab,ti OR 'post-intervention':ab,ti OR 'postintervention':ab,ti OR 'post intervention':ab,ti OR 'pre-post':ab,ti OR 'pre test':ab,ti OR 'pretest':ab,ti OR 'posttest':ab,ti OR 'post test':ab,ti OR 'quality improving':ab,ti OR 'quality improvement':ab,ti OR 'quality management':ab,ti OR 'quality care':ab,ti OR 'quality healthcare':ab,ti

#14 #12 OR #13

#15 #8 OR #11 OR #14

#16 'device removal'/exp

#17 'remov\*':ab,ti OR 'inappropriate\*':ab,ti OR 'appropriate\*':ab,ti OR 'unnecessary':ab,ti OR 'idle':ab,ti OR 'unuse\*':ab,ti OR 'unjustif\*':ab,ti OR 'adequacy':ab,ti OR 'redundant':ab,ti

#18 #16 OR #17

#19 #4 AND #15 AND #18

**CINAHL**

**1/31/2018**

332 Results

No limits applied

**8/28/2018**

22 Results

Limited to 2/1/2018-Present

S1 MH "Catheterization, Central Venous+"

S2 MH "Central Venous Catheters+"

S3 AB "central catheter" OR AB "central catheterization" OR AB "central line" OR AB "central venous catheter" OR AB "central venous catheterization" OR AB "central venous line" OR AB "venous cannulation" OR AB "venous access" OR AB "venous catheter" OR AB "venous catheterization" OR AB "vein cannulation" OR AB "vein access" OR AB "vein catheter" OR AB "vein catheterization" OR AB "vascular access device" OR AB portacath OR AB "peripherally inserted central catheter" OR AB groshong OR AB broviac OR AB hickman

S4 S1 OR S2 OR S3

S5 MH "Ultrasonography+"

S6 MH "Ultrasonics+

S7 AB ultrasound OR AB ultrasonic OR AB ultrasonography

S8 S5 OR S6 OR S7

S9 MH "Reminder Systems"

S10 AB reminder

S11 S9 OR S10

S12 MH "Quality Improvement+"

S13 AB intervention OR AB preintervention OR AB pre intervention OR AB pre-intervention OR AB post-intervention OR AB postintervention OR AB post intervention OR AB pre-post OR AB pre test OR AB pretest OR AB posttest OR AB post test OR AB quality improving OR AB quality improvement OR AB quality management OR AB quality care OR AB quality healthcare

S14 S12 OR S13

S15 S8 OR S11 OR S14

S16 MH "Device Removal+"

S17 AB remov\* OR AB inappropriate\* OR AB appropriate\* OR AB unnecessary OR AB idle OR AB unuse\* OR AB unjustif\* OR AB adequacy OR AB redundant

S18 S16 OR S17

S19 S4 AND S15 AND S18

**CENTRAL**

**1/31/2018**

107 Results

No limits applied

**8/28/2018**

11 Results

Limited to 2/1/2018-Present

#1 MeSH descriptor: [Catheterization, Central Venous] explode all trees

#2 MeSH descriptor: [Central Venous Catheters] explode all trees

#3 "central catheter":ti,ab,kw or "central catheterization":ti,ab,kw or "central line":ti,ab,kw or "central venous catheter":ti,ab,kw or "central venous catheterization":ti,ab,kw or "central venous line":ti,ab,kw or "venous cannulation":ti,ab,kw or "venous access":ti,ab,kw or "venous catheter":ti,ab,kw or "venous catheterization":ti,ab,kw or "vein access":ti,ab,kw or "vein catheter":ti,ab,kw or "vein catheterization":ti,ab,kw or "vascular access device":ti,ab,kw or portacath:ti,ab,kw or "peripherally inserted central catheter":ti,ab,kw or groshong:ti,ab,kw or broviac:ti,ab,kw or hickman:ti,ab,kw (Word variations have been searched)

#4 #1 OR #2 OR #3

#5 MeSH descriptor: [Ultrasonography] explode all trees

#6 MeSH descriptor: [Ultrasonography, Interventional] explode all trees

#7 ultrasound:ti,ab,kw or ultrasonic:ti,ab,kw or ultrasonography:ti,ab,kw (Word variations have been searched)

#8 #5 OR #6 OR #7

#9 MeSH descriptor: [Reminder Systems] explode all trees

#10 reminder:ti,ab,kw (Word variations have been searched)

#11 #9 OR #10

#12 MeSH descriptor: [Quality Improvement] explode all trees

#13 "intervention":ti,ab,kw or "preintervention":ti,ab,kw or "pre intervention":ti,ab,kw or "pre-intervention":ti,ab,kw or "post-intervention":ti,ab,kw or "postintervention":ti,ab,kw or "post intervention":ti,ab,kw or "pre-post":ti,ab,kw or "pre test":ti,ab,kw or "pretest":ti,ab,kw or "posttest":ti,ab,kw or "post test":ti,ab,kw or "quality improving":ti,ab,kw or "quality improvement":ti,ab,kw or “quality management”:ti,ab,kw or "quality care":ti,ab,kw or “quality healthcare”:ti,ab,kw (Word variations have been searched)

#14 #12 OR #13

#15 #8 OR #11 OR #14

#16 'device removal'/exp

#17 "remov\*":ti,ab,kw or "inappropriate\*":ti,ab,kw or "appropriate\*":ti,ab,kw or "unnecessary":ti,ab,kw or "unuse\*":ti,ab,kw or "unjustif\*":ti,ab,kw or "adequacy":ti,ab,kw or "redundant":ti,ab,kw (Word variations have been searched)

#18 #16 OR #17

#19 #4 AND #15 AND #18

**Supplementary Materials. Quality of Included Studies**

|  |
| --- |
| **The Cochrane ‘Risk of bias’ table for Randomized Controlled Trials** |
| Study | Random sequence generation | Allocation concealment | Blinding of participants and personnel | Blinding of outcome assessment | Incomplete outcome data | Selective reporting | Other bias | Overall appraisal |
|
| Rattanaumpawan27 | Low risk | High risk | High risk | Low risk | Low risk | Low risk | Unclear risk | Medium risk |
| **The Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Quasi-Experimental Studies** |
| Study | Clear cause and effect | Similar participants | Similar treatment | There is a control group | Multiple measurements of the outcome | Comple-te follow up | Outcomes measured in the same way | Outcomes measured in a reliable way | Appropriate statistics | Overall appraisal |
|
| Arora15 | Yes | Yes | Yes | No | No | Yes | Yes | Yes | Yes | B |
| Chandra-mohan16 | Yes | Unclear | Yes | No | No | Yes | Yes | Yes | Yes | B |
| Deutsch17 | Yes | Yes | Yes | No | No | Yes | Yes | No | Yes | C |
| Grady25 | Yes | Unclear | Yes | No | No | Yes | Yes | Yes | Yes | B |
| Morata18 | No | Unclear | Yes | No | Yes | Yes | Yes | Yes | Yes | B |
| Reeves19 | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | A |
| Seguin27 | Yes | No | Yes | No | No | Yes | Yes | Yes | Yes | B |
| Swamina-than20 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | A |
| Weeks21 | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | A |
| **The Newcastle-Ottawa Scale (NOS) for Cohort Studies** |
| Study | Representativeness of the exposed cohort | Selection of the non-exposed cohort | Ascertainment of exposure | Outcome was not present at start of study | Compara-bility of cohorts | Outcome assessment | Enoughfollow-up | Adequacy of follow up | Overall appraisal |
|
| AU22 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 7 |
| Galen23 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 |
| Ilan26 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 9 |
| Mccarthy24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 |