**Supplementary appendix**

**A Systematic Review of the Burden of Multidrug-resistant Healthcare-associated Infections among Intensive Care Unit Patients in Southeast Asia: The Rise of Multidrug-resistant *Acinetobacter baumannii***

Nattawat Teerawattanapong, Pornpansa Panich, Disorn Kulpokin, Siriwat Na Ranong,

Khachen Kongpakwattana, Atibodi Saksinanon, Bey-Hing Goh, Learn-Han Lee,

Anucha Apisarnthanarak, Nathorn Chaiyakunapruk

September 30th, 2017

**Table of contents**

|  |  |  |
| --- | --- | --- |
| Appendix 1 | Search strategies……………………………………………………………………………………....... | 3 |
|  eTable 1.1 | Search algorithms……………………………………………………………………………………..... | 3 |
| Appendix 2 | Description of included studies………………………………………………………………………… | 6 |
|  eTable 2.1 | Description of included studies…………………………………………………………………………  | 6 |
| Appendix 3 | Quality assessments…………………………………………………………………………………….. | 10 |
|  eTable 3.1 | Quality assessment of studies…………………………………………………………………………... | 10 |
| Appendix 4 | Cumulative incidence and prevalence………………………………………………………………….. | 11 |
|  eTable 4.1 | Prevalence rate of HAI due to MDRO in Southeast Asia……………………………………………… | 11 |
| Appendix 5 | References of included studies…………………………….…………………………….……………... | 14 |

**Appendix 1**

**Search strategies**

**eTable 1.1 Search algorithms**

|  | **Search algorithm** |
| --- | --- |
| #1 | *Acinetobacter baumannii* |
| #2 | *Pseudomonas aeruginosa* |
| #3 | *Escherichia coli* |
| #4 | *Klebsiella pneumoniae* |
| #5 | Enterobacteriaceae |
| #6 | Staphylococc\* |
| #7 | Enterococc\* |
| #8 | microorganism\* |
| #9 | bacteria |
| #10 | #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 |
| #11 | “Extended-spectrum beta-lactamase” |
| #12 | ESBL |
| #13 | “Multidrug-resistant” |
| #14 | “Multidrug resistance” |
| #15 | Multiresistan\* |
| #16 | Multi-resistan\* |
| #17 | MDR |
| #18 | “Extensively drug-resistant” |
| #19 | “Extensively drug resistance” |
| #20 | XDR |
| #21 | “Pandrug-resistant” |
| #22 | “Pandrug resistance” |
| #23 | PDR |
| #24 | “Carbapenem-resistant” |
| #25 | “Carbapenem resistance” |
| #26 | Carbapenemase |
| #27 | KPC |
| #28 | “Colistin-resistant” |
| #29 | “Colistin resistantance” |
| #30 | “Polymyxin-resistant” |
| #31 | “Polymyxin resistance” |
| #32 | “Methicillin-resistant” |
| #33 | “Methicillin resistantance” |
| #34 | MRSA |
| #35 | MRSE |
| #36 | “Vancomycin-resistant” |
| #37 | “Vancomycin resistance”  |
| #38 | VRSA |
| #39 | VRSE |
| #40 | VRE |
| #41 | #11 OR #12 OR #13 OR #14# OR 15 OR #16 OR #17# OR 18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40 |
| #42 | “Intensive care unit” |
| #43 | ICU |
| #44 | “Critically ill” |
| #45 | #42 OR #43 OR #44 |
| #46 | Prevalence |
| #47 | Incidence |
| #48 | “ICU stay” |
| #49 | “Hospital stay” |
| #50 | “Length of stay” |
| #51 | Mortality |
| #52 | Fatality |
| #53 | Cost |
| #54 | #46 OR #47 OR #48 OR #49 OR #50 OR #51 OR #52 OR #53 |
| #55 | “Healthcare-associated” |
| #56 | “Hospital-acquired” |
| #57 | “Nosocomial” |
| #58 | “Device-associated” |
| #59 | “Central line-associated” |
| #60 | “Ventilator-associated” |
| #61 | “Catheter-associated” |
| #62 | #55 OR #56 OR #57 OR #58 OR #59 OR #60 OR #61 |
| #63 | Infection\* |
| #64 | “Bloodstream infection” |
| #65 | “Bloodstream infections” |
| #66 | Bacteraemia |
| #67 | Bacteremia |
| #68 | Septicaemia |
| #69 | Septicemia |
| #70 | Pneumonia |
| #71 | “Urinary tract infection” |
| #72 | “Urinary tract infections” |
| #73 | “Surgical site infection” |
| #74 | “Surgical site infections” |
| #75 | “Wound infection” |
| #76 | “Wound infections” |
| #77 | #63 OR #64 OR #65 OR #66 OR #67 OR #68 OR #69 OR #70 OR #71 OR #72 OR #73 OR #74 OR #75 OR #76 |
| #78 | Burma |
| #79 | Brunei |
| #80 | Cambodia |
| #81 | “East Timor” |
| #82 | Indonesia |
| #83 | Laos |
| #84 | Malaysia |
| #85 | Myanmar |
| #86 | Philippines |
| #87 | Singapore |
| #88 | Thailand |
| #89 | Vietnam |
| #90 | #78 OR #79 OR #80 OR #81 OR #82 OR #83 OR #84 OR #85 OR #86 OR #87 OR #88 OR #89 |
| #91 | #10 AND #41 AND #45 AND #54 AND #62 AND #77 AND #90 |

**Appendix 2**

**Description of included studies**

**eTable 2.1 Description of included studies**

| **ID** | **First author** | **Year of publication** | **Country of publication** | **MDROa** | **Type of HAIb** | **Type of ICUc** | **No. of patientsd** | **Incidence** | **Prevalence** | **CFR** | **LOS** | **Cost** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | Boonyasiri A1 | 2016 | Thailand | ESBL-EC, ESBL-KP, MDR-AB, MDR-PsA, MRSA, VRE | Colonization, CAUTI, CLABSI | MICU | 388 | 1 | 1 |  |  |  |
| 2 | Le NK2 | 2016 | Vietnam | CRAB, CRE, CR-KP, CR-PsA, MRSA | Any HAI | PICU | 1,363 | 1 | 1 |  |  |  |
| 3 | Thatrimontrichai A3 | 2016 | Thailand | CRAB | VAP | NICU | 101e |  | 1 | 1 | 1 |  |
| 4 | Turner P4 | 2016 | Cambodia | CRAB, ESBL-E | Colonization | NICU | 333 | 1 |  |  |  |  |
| 5 | Chusri S5 | 2015 | Thailand | MDR-AB | Any HAI | ICU | 69e |  | 1 |  |  |  |
| 6 | Harris PN6 | 2015 | Singapore | MRSA | Any HAI, BSI, colonization | ICU | 649 | 1 |  |  |  |  |
| 7 | Inchai J(1)7 | 2015 | Thailand | MDR-AB, PDR-AB, XDR-AB, MRSA | VAP | MICU | 621e |  | 1 | 1 |  |  |
| 8 | Inchai J(2)8 | 2015 | Thailand | MDR-AB, PDR-AB, XDR-AB | VAP | MICU | 304e |  |  | 1 |  |  |
| 9 | Janahiraman S9 | 2015 | Malaysia | MDR-AB | VAP | ICU | 136e |  | 1 |  | 1 |  |
| 10 | Ling ML10 | 2015 | Singapore | CRE | Colonization/infection | Adult ICU | 203e |  |  | 1 | 1 |  |
| 11 | Tong SY11 | 2015 | Thailand | MRSA | Colonization | MICU, PICU | 267 | 1 |  |  |  |  |
| 12 | Apisarnthanarak A12 | 2014 | Thailand | ESBL-EC, ESBL-KP, MDR-PsA, MRSA, XDR-AB | Colonization/infection | ICU | 554 | 1 |  |  |  |  |
| 13 | Chittawatanarat K13 | 2014 | Thailand | MDR-AB, MDR-E, MRSA, XDR-AB | VAP | SICU | 150e |  | 1 | 1 |  |  |
| 14 | Saharman YR14 | 2013 | Indonesia | ESBL-E | Any HAI | ICU | 84e |  | 1 | 1 |  |  |
| 15 | Schultsz C15 | 2013 | Vietnam | ESBL-E, MRSA | Colonization/infection | Tetanus ICU | 174 | 1 |  |  |  |  |
| 16 | Thatrimontrichai A16 | 2013 | Thailand | CRAB | BSI | NICU | 368e |  | 1 | 1 | 1 |  |
| 17 | Vasudevan A(1)17 | 2013 | Singapore | MDR-GNB | Colonization/infection | MICU, SICU | 1,373 | 1 |  |  |  |  |
| 18 | Vasudevan A(2)18 | 2013 | Singapore | MDR-AB, MDR-EC, MDR-KP, MDR-PsA, MRSA | Pneumonia | MICU, SICU | 246e |  | 1 |  |  |  |
| 19 | Le T19 | 2012 | Vietnam | CRAB, MDR-AB | VAP | MICU, SICU | 51e |  | 1 |  |  |  |
| 20 | Nakwan N20 | 2012 | Thailand | CRAB | BSI | NICU | 4,087 | 1 | 1 | 1 |  |  |
| 21 | Ng E21 | 2012 | Singapore | MDR-GNB | BSI | MICU, SICU | 525e |  |  |  |  | 1 |
| 22 | Chong SJ22 | 2011 | Singapore | MDR-AB, MRSA | Any HAI, BSI, CLABSI, UTI, VAP, wound infection | Burn ICU | 94 | 1 |  |  |  |  |
| 23 | Nakwan N23 | 2011 | Thailand | XDR-AB | VAP | NICU | 670 | 1 | 1 | 1 |  |  |
| 24 | Oh HM24 | 2011 | Singapore | MRSA | Colonization | SICU | 453 | 1 |  |  |  |  |
| 25 | Katherason SG25 | 2010 | Malaysia | ESBL-KP, MRSA | BSI | Adult ICU | 215 | 1 | 1 |  |  |  |
| 26 | Kurup A26 | 2010 | Singapore | MRSA | Colonization | MICU, SICU | 213 | 1 |  |  | 1 |  |
| 27 | Donaldson AD27 | 2009 | Singapore | MDR-AB, MDR-PsA, MRSA | BSI | Adult ICU | 415 | 1 |  | 1 | 1 |  |
| 28 | Gill CJ28 | 2009 | Philippines | MRSA, VRE | Colonization | NICU | 925 | 1 |  |  |  |  |
| 29 | Katherason SG29 | 2009 | Malaysia | ESBL-KP, MRSA | VAP | Adult ICU | 215 | 1 |  |  |  |  |
| 30 | Litzow JM30 | 2009 | Philippines | MDR-GNB | BSI, colonization | NICU | 1,831 | 1 |  |  |  |  |
| 31 | Sritippayawan S31 | 2009 | Thailand | MDR-E, MDR-AB, MDR-PsA, MRSA/MRSE, VRE | Any HAI | PICU | 347 | 1 | 1 | 1 |  |  |
| 32 | Apisarnthanarak A32 | 2008 | Thailand | PDR-AB | Colonization/infection | Adult ICU | 1,357 | 1 |  |  |  | 1 |
| 33 | Katherason SG33 | 2008 | Malaysia | ESBL-KP, MRSA | BSI, pneumonia | Adult ICU | 128 | 1 |  |  |  |  |
| 34 | Chim H34 | 2007 | Singapore | CoR-AB, CRAB, MRSA | Any HAI, BSI, burn wound infection, pneumonia, primary BSI, wound colonization | Burn ICU | 57 | 1 | 1 |  |  |  |
| 35 | Kwa AL35 | 2007 | Singapore | MDR-AB | Pneumonia | SICU | 129e |  | 1 |  |  |  |
| 36 | Tan CC36 | 2007 | Malaysia | ESBL-E, MDR-AB, MRSA | CLABSI | Adult ICU | 496 | 1 | 1 |  |  |  |
| 37 | Boo NY37 | 2005 | Malaysia | ESBL-KP | Colonization | NICU | 369 | 1 |  |  |  |  |
| 38 | Ling ML38 | 2001 | Singapore | MDR-AB | Any HAI, colonization | ICU | 103e |  |  | 1 | 1 |  |
| 39 | Ng SP39 | 1998 | Singapore | MRSA/MRSE | BSI | NICU | 227 | 1 |  |  |  |  |
| 40 | Halder D40 | 1996 | Malaysia | MRSA | Septic arthritis | NICU | 10e |  | 1 |  |  |  |
| 41 | Tan KW41 | 1994 | Singapore | MRSA | Any HAI, colonization | NICU | 2,576 | 1 |  |  |  |  |

**Abbreviations:**

aCoR-AB, colistin-resistant *A. baumannii*; CRAB, carbapenem-resistant *A. baumannii*; CRE, carbapenem-resistant Enterobacteriaceae; CR-KP, carbapenem-resistant *K. pneumoniae*; CR-PsA, carbapenem-resistant *P. aeruginosa*; ESBL-E, ESBL-producing Enterobacteriaceae; ESBL-EC, ESBL-producing *E. coli*; ESBL-KP, ESBL-producing *K. pneumoniae*; MDR-AB, multidrug-resistant *A. baumannii*; MDR-E, multidrug-resistant Enterobacteriaceae; MDR-EC, multidrug-resistant *E. coli*; MDR-GNB, multidrug-resistant Gram-negative bacteria; MDR-KP, multidrug-resistant *K. pneumoniae*; MDR-PsA, multidrug-resistant *P. aeruginosa*; MRSA, methicillin-resistant *S. aureus*; MRSE, methicillin-resistant *S. epidermidis*; PDR-AB, pandrug-resistant *A. baumannii*; VRE, vancomycin-resistant enterococci; XDR-AB, extensively drug-resistant *A. baumannii*.

bBSI, bloodstream infection; CAUTI, catheter-associated urinary tract infection; CLABSI, central line-associated bloodstream infection; HAI, healthcare-associated infection; VAP,

ventilator-associated pneumonia.

cMICU, medical ICU; NICU, neonatal ICU; PICU, pediatric ICU; SICU, surgical ICU.

dAll patients admitted to ICU.

eNumber of infected cases.

**Appendix 3**

**Quality assessments**

**eTable 3.1 Quality assessment of studies**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ID** | **First author** | **Year of publication** | **Quality** |  | **ID** | **First author** | **Year of publication** | **Quality** |
| 1 | Boonyasiri A | 2016 | HQ |  | 22 | Chong SJ | 2011 | HQ |
| 2 | Le NK | 2016 | HQ |  | 23 | Nakwan N | 2011 | MQ |
| 3 | Thatrimontrichai A | 2016 | MQ |  | 24 | Oh HM | 2011 | LQ |
| 4 | Turner P | 2016 | MQ |  | 25 | Katherason SG | 2010 | HQ |
| 5 | Chusri S | 2015 | HQ |  | 26 | Kurup A | 2010 | MQ |
| 6 | Harris PN | 2015 | HQ |  | 27 | Donaldson AD | 2009 | HQ |
| 7 | Inchai J(1) | 2015 | HQ |  | 28 | Gill CJ | 2009 | MQ |
| 8 | Inchai J(2) | 2015 | HQ |  | 29 | Katherason SG | 2009 | HQ |
| 9 | Janahiraman S | 2015 | MQ |  | 30 | Litzow JM | 2009 | HQ |
| 10 | Ling ML | 2015 | HQ |  | 31 | Sritippayawan S | 2009 | HQ |
| 11 | Tong SY | 2015 | MQ |  | 32 | Apisarnthanarak A | 2008 | HQ |
| 12 | Apisarnthanarak A | 2014 | HQ |  | 33 | Katherason SG | 2008 | HQ |
| 13 | Chittawatanarat K | 2014 | MQ |  | 34 | Chim H | 2007 | MQ |
| 14 | Saharman YR | 2013 | MQ |  | 35 | Kwa AL | 2007 | MQ |
| 15 | Schultsz C | 2013 | MQ |  | 36 | Tan CC | 2007 | MQ |
| 16 | Thatrimontrichai A | 2013 | MQ |  | 37 | Boo NY | 2005 | MQ |
| 17 | Vasudevan A(1) | 2013 | MQ |  | 38 | Ling ML | 2001 | LQ |
| 18 | Vasudevan A(2) | 2013 | HQ |  | 39 | Ng SP | 1998 | MQ |
| 19 | Le T | 2012 | LQ |  | 40 | Halder D | 1996 | LQ |
| 20 | Nakwan N | 2012 | MQ |  | 41 | Tan KW | 1994 | MQ |
| 21 | Ng E | 2012 | MQ |  |  |  |  |  |

**Abbreviations:** HQ, high quality; MQ, moderate quality; LQ, low quality.

**Appendix 4**

**Cumulative incidence and prevalence**

**eTable 4.1 Prevalence rate of HAI due to MDRO in Southeast Asia**

|  |  |  |  |
| --- | --- | --- | --- |
| **Microorganism** | **Type of infection** | **Range, %** | **Studies** |
| **Prevalence of drug-resistant cases among patients infected with the same pathogen** |
| ESBL-producing GNB | Any HAI | 58.33 | Saharman et al, 2013 (Indonesia)14 |
|  | BSI | 75.00 | Katherason et al, 2010 (Malaysia)25 |
| CRAB | BSI | 59.09 | Nakwan et al, 2012 (Thailand)20 |
|  | VAP | 88.24 | Le et al, 2012 (Vietnam)19 |
| MDR-AB | Any HAI | 69.57-78.26 | Chusri et al, 2015 (Thailand)5; Sritippayawan et al, 2009 (Thailand)31 |
|  | Pneumonia | 77.36 | Vasudevan(2), 2013 (Singapore)18 |
|  | VAP | 3.45-100.00 | Inchai(1) et al, 2015 (Thailand)7; Janahiraman et al, 2015 (Malaysia)9; Chittawatanarat et al, 2014 (Thailand)13; Le et al, 2012 (Vietnam)19 |
| MDR-PsA | Any HAI | 55.56 | Sritippayawan et al, 2009 (Thailand)31 |
|  | Pneumonia | 25.40 | Vasudevan(2) et al, 2013 (Singapore)18 |
| MDR-Enterobacteriaceae | Any HAI | 44.44 | Sritippayawan et al, 2009 (Thailand)31 |
|  | Pneumonia | 17.86-50.00 | Vasudevan(2) et al, 2013 (Singapore)18 |
|  | VAP | 33.33 | Chittawatanarat et al, 2014 (Thailand)13 |
| MDR-GNB | Pneumonia | 31.78 | Kwa et al, 2007 (Singapore)35 |
| XDR-AB | VAP | 65.28-79.31 | Inchai(1) et al, 2015 (Thailand)7; Chittawatanarat et al, 2014 (Thailand)13 |
| PDR-AB | VAP | 3.56 | Inchai(1) et al, 2015 (Thailand)7 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Microorganism** | **Type of infection** | **Range, %** | **Studies** |
| MRSA | Any HAI | 33.33 | Sritippayawan et al, 2009 (Thailand)31 |
|  | Pneumonia | 59.21 | Vasudevan(2) et al, 2013 (Singapore)18 |
|  | VAP | 66.67 | Chittawatanarat et al, 2014 (Thailand)13 |
| VRE | Any HAI | 40.00 | Sritippayawan et al, 2009 (Thailand)31 |
| **Prevalence of drug-resistant cases among patients infected with any pathogen** |
| ESBL-producing GNB | CLABSI | 18.42 | Tan et al, 2007 (Malaysia)36 |
| CRAB | Any HAI | 5.29 | Le et al, 2016 (Vietnam)2 |
|  | BSI | 3.80 | Thatrimontrichai et al, 2013 (Thailand)16 |
|  | VAP | 62.38 | Thatrimontrichai et al, 2016 (Thailand)3 |
| CR-PsA | Any HAI | 5.29 | Le et al, 2016 (Vietnam)2 |
| CRE | Any HAI | 3.08-5.07 | Le et al, 2016 (Vietnam)2 |
| MDR-AB | CLABSI | 10.53 | Tan et al, 2007 (Malaysia)36 |
|  | VAP | 1.33-11.59 | Inchai(1) et al, 2015 (Thailand)7; Chittawatanarat et al, 2014 (Thailand)13 |
| MDR-Enterobacteriaceae | VAP | 8.67 | Chittawatanarat et al, 2014 (Thailand)13 |
| MDR-GNB and GPC | HAP | 41.87 | Vasudevan(2), 2013 (Singapore)18 |
|  | VAP | 40.58 | Vasudevan(2), 2013 (Singapore)18 |
| XDR-AB | VAP | 17.95-35.43 | Inchai(1) et al, 2015 (Thailand)7; Chittawatanarat et al, 2014 (Thailand)13; Nakwan et al, 2011 (Thailand)23 |
| PDR-AB | VAP | 1.93 | Inchai(1) et al, 2015 (Thailand)7 |
| MRSA | Any HAI | 2.86 | Le et al, 2016 (Vietnam)2 |
|  | BSI | 17.70 | Chim et al, 2007 (Singapore)34 |
|  | Primary BSI | 7.41 | Chim et al, 2007 (Singapore)34 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Microorganism** | **Type of infection** | **Range, %** | **Studies** |
| MRSA | CLABSI | 13.16-16.67 | Boonyasiri et al, 2016 (Thailand)1; Tan et al, 2007 (Malaysia)36 |
|  | CAUTI | 3.33 | Boonyasiri et al, 2016 (Thailand)1 |
|  | Burn wound infection | 23.40 | Chim et al, 2007 (Singapore)34 |
|  | Septic arthritis | 90.00 | Halder et al, 1996 (Malaysia)40 |
|  | Pneumonia | 18.64 | Chim et al, 2007 (Singapore)34 |
|  | VAP | 2.67 | Chittawatanarat et al, 2014 (Thailand)13 |

**Abbreviations:** BSI, bloodstream infection; CAUTI, catheter-associated urinary tract infection; CLABSI, central line-associated bloodstream infection; CRAB, carbapenem-resistant *Acinetobacter baumannii*; CRE, carbapenem-resistant Enterobacteriaceae; CR-PsA, carbapenem-resistant *Pseudomonas aeruginosa*; HAP, hospital-acquired pneumonia; MDR-AB, multidrug-resistant *Acinetobacter baumannii*; MDR-GNB and GPC, multidrug-resistant Gram-negative bacteria and Gram-positive cocci; MDR-PsA, multidrug-resistant *Pseudomonas aeruginosa*; MRSA, methicillin-resistant *Staphylococcus aureus*; PDR-AB, pandrug-resistant *Acinetobacter baumannii*; VAP, ventilator-associated pneumonia; VRE, vancomycin-resistant *Enterococcus* spp.; XDR-AB, extensively drug-resistant *Acinetobacter baumannii*.

**Appendix 5**

**References of included studies**

**1.** Boonyasiri A, Thaisiam P, Permpikul C, et al. Effectiveness of chlorhexidine wipes for the prevention of multidrug-resistant bacterial colonization and hospital-acquired infections in intensive care unit patients: A randomized trial in Thailand. *Infect Control Hosp Epidemiol* 2016;37:245-253.

**2.** Le NK, Hf W, Vu PD, et al. High prevalence of hospital-acquired infections caused by gram-negative carbapenem resistant strains in Vietnamese pediatric ICUs. *Medicine (Baltimore)* 2016;95:e4099.

**3.** Thatrimontrichai A, Techato C, Dissaneevate S, et al. Risk factors and outcomes of carbapenem-resistant Acinetobacter baumannii ventilator-associated pneumonia in the neonate: A case-case-control study. *J Infect Chemother* 2016;22:444-449.

**4.** Turner P, Pol S, Soeng S, et al. High prevalence of antimicrobial-resistant Gram-negative colonization in hospitalized Cambodian infants. *Pediatr Infect Dis J* 2016;35:856-861.

**5.** Chusri S, Silpapojakul K, McNeil E, Singkhamanan K, Chongsuvivatwong V. Impact of antibiotic exposure on occurrence of nosocomial carbapenem-resistant Acinetobacter baumannii infection: a case control study. *J Infect Chemother* 2015;21:90-95.

**6.** Harris PN, Le BD, Tambyah P, et al. Antiseptic body washes for reducing the transmission of methicillin-resistant Staphylococcus aureus: A cluster crossover study. *Open Forum Infect Dis* 2015;2:ofv051.

**7.** Inchai J, Pothirat C, Liwsrisakun C, Deesomchok A, Kositsakulchai W, Chalermpanchai N. Ventilator-associated pneumonia: epidemiology and prognostic indicators of 30-day mortality. *Jpn J Infect Dis* 2015;68:181-186.

**8.** Inchai J, Pothirat C, Bumroongkit C, Limsukon A, Khositsakulchai W, Liwsrisakun C. Prognostic factors associated with mortality of drug-resistant Acinetobacter baumannii ventilator-associated pneumonia. *J Intensive Care* 2015;3:9.

**9.** Janahiraman S, Aziz MN, Hoo FK, et al. Resistance patterns of multidrug resistant Acinetobacter baumannii in an ICU of a tertiary care hospital, Malaysia. *Pak J Med Sci* 2015;31:1383-1388.

**10.** Ling ML, Tee YM, Tan SG, et al. Risk factors for acquisition of carbapenem resistant Enterobacteriaceae in an acute tertiary care hospital in Singapore. *Antimicrob Resist Infect Control* 2015;4:26.

**11.** Tong SY, Holden MT, Nickerson EK, et al. Genome sequencing defines phylogeny and spread of methicillin-resistant Staphylococcus aureus in a high transmission setting. *Genome Res* 2015;25:111-118.

**12.** Apisarnthanarak A, Pinitchai U, Warachan B, Warren DK, Khawcharoenporn T, Hayden MK. Effectiveness of infection prevention measures featuring advanced source control and environmental cleaning to limit transmission of extremely-drug resistant Acinetobacter baumannii in a Thai intensive care unit: An analysis before and after extensive flooding. *American journal of infection control* 2014;42:116-121.

**13.** Chittawatanarat K, Jaipakdee W, Chotirosniramit N, Chandacham K, Jirapongcharoenlap T. Microbiology, resistance patterns, and risk factors of mortality in ventilator-associated bacterial pneumonia in a Northern Thai tertiary-care university based general surgical intensive care unit. *Infect Drug Resist* 2014;7:203-210.

**14.** Saharman YR, Lestari DC. Phenotype characterization of Beta-lactamase producing enterobacteriaceae in the intensive care unit (ICU) of Cipto Mangunkusumo Hospital in 2011. *Acta Med Indones* 2013;45:11-16.

**15.** Schultsz C, Bootsma MC, Loan HT, et al. Effects of infection control measures on acquisition of five antimicrobial drug-resistant microorganisms in a tetanus intensive care unit in Vietnam. *Intensive Care Med* 2013;39:661-671.

**16.** Thatrimontrichai A, Apisarnthanarak A, Chanvitan P, Janjindamai W, Dissaneevate S, Maneenil G. Risk factors and outcomes of carbapenem-resistant Acinetobacter baumannii bacteremia in neonatal intensive care unit: a case-case-control study. *Pediatr Infect Dis J* 2013;32:140-145.

**17.** Vasudevan A, Mukhopadhyay A, Goh EY, Li J, Tambyah PA. Risk factors for infection/colonization caused by resistant Gram negative bacilli in critically ill patients (an observational study of 1633 critically ill patients). *Prev Med* 2013;57 Suppl:S70-73.

**18.** Vasudevan A, Chuang L, Jialiang L, Mukhopadhyay A, Goh EY, Tambyah PA. Inappropriate empirical antimicrobial therapy for multidrug-resistant organisms in critically ill patients with pneumonia is not an independent risk factor for mortality: Results of a prospective observational study of 758 patients. *J Glob Antimicrob Resist* 2013;1:123-130.

**19.** Le T, Nga TTT, Minoru A, Kirikae T. Ventilation associated pneumonia caused by Acinetobacter baumannii at a tertiary hospital in Vietnam: Clinical and molecular patterns. *American journal of infection control* 2012;40:e53.

**20.** Nakwan NW, J., Patungkalo W, Chokephaibulkit K. Clinical features, risk factors, and outcome of carbapenem-resistant Acinetobacter baumannii bacteremia in a Thai neonatal intensive care unit. *Asian Biomedicine* 2012;6:473-479.

**21.** Ng E, Earnest A, Lye DC, Ling ML, Ding Y, Hsu LY. The excess financial burden of multidrug resistance in severe gram-negative infections in Singaporean hospitals. *Ann Acad Med Singapore* 2012;41:189-193.

**22.** Chong SJ, Ahmed S, Tay JM, Song C, Tan TT. 5 year analysis of bacteriology culture in a tropical burns ICU. *Burns* 2011;37:1349-1353.

**23.** Nakwan N, Wannaro J, Thongmak T, et al. Safety in treatment of ventilator-associated pneumonia due to extensive drug-resistant Acinetobacter baumannii with aerosolized colistin in neonates: a preliminary report. *Pediatr Pulmonol* 2011;46:60-66.

**24.** Oh HM, Tan TY, Chua GH, Li J, Meng QS. The impact of active surveillance cultures in reducing methicillin-resistant Staphylococcus aureus infections in a surgical intensive care unit in Singapore. *BMC Proc* 2011;5:P233.

**25.** Katherason SG, Naing L, Jaalam K, et al. Prospective surveillance of nosocomial device-associated bacteremia in three adult intensive units in Malaysia. *Trop Biomed* 2010;27:308-316.

**26.** Kurup A, Chlebicka N, Tan KY, et al. Active surveillance testing and decontamination strategies in intensive care units to reduce methicillin-resistant Staphylococcus aureus infections. *American journal of infection control* 2010;38:361-367.

**27.** Donaldson AD, Razak L, Liang LJ, Fisher DA, Tambyah PA. Carbapenems and subsequent multiresistant bloodstream infection: does treatment duration matter? *Int J Antimicrob Agents* 2009;34:246-251.

**28.** Gill CJ, Mantaring JB, Macleod WB, et al. Impact of enhanced infection control at 2 neonatal intensive care units in the Philippines. *Clin Infect Dis* 2009;48:13-21.

**29.** Katherason SG, Naing L, Jaalam K, et al. Ventilator-associated nosocomial pneumonia in intensive care units in Malaysia. *J Infect Dev Ctries* 2009;3:704-710.

**30.** Litzow JM, Gill CJ, Mantaring JB, et al. High frequency of multidrug-resistant gram-negative rods in 2 neonatal intensive care units in the Philippines. *Infect Control Hosp Epidemiol* 2009;30:543-549.

**31.** Sritippayawan S, Sri-Singh K, Prapphal N, Samransamruajkit R, Deerojanawong J. Multidrug-resistant hospital-associated infections in a pediatric intensive care unit: a cross-sectional survey in a Thai university hospital. *Int J Infect Dis* 2009;13:506-512.

**32.** Apisarnthanarak A, Pinitchai U, Thongphubeth K, Yuekyen C, Warren DK, Fraser VJ. A multifaceted intervention to reduce pandrug-resistant Acinetobacter baumannii colonization and infection in 3 intensive care units in a Thai tertiary care center: a 3-year study. *Clin Infect Dis* 2008;47:760-767.

**33.** Katherason SG, Naing L, Jaalam K, Ismail A. Baseline assessment of intensive care-acquired nosocomial infection surveillancein three adult intensive care units in Malaysia. *J Infect Dev Ctries* 2008;2:364-368.

**34.** Chim H, Tan BH, Song C. Five-year review of infections in a burn intensive care unit: High incidence of Acinetobacter baumannii in a tropical climate. *Burns* 2007;33:1008-1014.

**35.** Kwa AL, Low JG, Lee E, Kurup A, Chee HL, Tam VH. The impact of multidrug resistance on the outcomes of critically ill patients with Gram-negative bacterial pneumonia. *Diagn Microbiol Infect Dis* 2007;58:99-104.

**36.** Tan CC, Zanariah Y, Lim KI, Balan S. Central venous catheter-related blood stream infections: Incidence and an analysis of risk factors. *Med J Malaysia* 2007;62:370-374.

**37.** Boo NY, Ng SF, Lim VK. A case-control study of risk factors associated with rectal colonization of extended-spectrum beta-lactamase producing Klebsiella sp. in newborn infants. *J Hosp Infect* 2005;61:68-74.

**38.** Ling ML, Ang A, Wee M, Wang GC. A nosocomial outbreak of multiresistant Acinetobacter baumannii originating from an intensive care unit. *Infect Control Hosp Epidemiol* 2001;22:48-49.

**39.** Ng SP, Gomez JM, Lim SH, Ho NK. Reduction of nosocomial infection in a neonatal intensive care unit (NICU). *Singapore Med J* 1998;39:319-323.

**40.** Halder D, Seng QB, Malik AS, Choo KE. Neonatal septic arthritis. *Southeast Asian J Trop Med Public Health* 1996;27:600-605.

**41.** Tan KW, Tay L, Lim SH. An outbreak of methicillin-resistant Staphylococcus aureus in a neonatal intensive care unit in Singapore: a 20-month study of clinical characteristics and control. *Singapore Med J* 1994;35:277-282.