Supplementary Information

Infection Control Programs and Antibiotic Control Programs to Limit Transmission of Multi-Drug Resistant *Acinetobacter baumannii* Infections: Evolution of Old Problems and New Challenges for Institutes

Table S1. Risk factors for acquisition of AB infection (including acquisition of multi-drug-resistant *Acinetobacter baumannii).*

Author/Year	Study Design	Risk Factors
(1) Environment		
environmental contamination		
Ho CM/2013	Case-control study, prospective	Environment contamination
Hosoglu S/2013	Case-control study	Environment contamination
Pimentel JD/2005	Non-case-control study	Environmental contamination (improper cleaning methods used on respiratory equipment)
Wroblewska MM/2004	Non-case-control study	Environmental contamination (suctioning equipment of the neurosurgery ward, mattress, resuscitation equipment, steel trolley)
El Shafie SS/2004	Non-case-control study	Environmental contamination (bedrails, curtains, suction with vacuum, ambu bags, ventilation filters)
Ferreira AC/2004	Non-case-control study	Cross-transmission
Mittal N/2003	Non-case-control study	Environmental contamination (intravenous catheters, washbasin)
Wang SH/2003	Non-case-control study	Environmental contamination (bed rails, bedside tables, surface of ventilators and infusion pumps, water for nasogastric feeding and ventilator rinsing, and sinks)
Melamed R/2003	Non-case-control study	Environmental contamination (hygroscopic bandages and umbilical catheters)

Table S1. *Cont.*

Author/ Year	Study Design	Risk Factors
Hsueh PR/2002	Non-case-control study	Environmental contamination (ventilator monitor board and tips of feeding syringe)
Huang YC/2002	Non-case-control study	Environmental contamination (contaminated hands of healthcare workers, bed rails, ventilator, incubator, heater)
Aygun G/2002	Non-case-control study	Environmental contamination (beds, tables, infusion pumps, pulse oximeters, blood pressure cuffs, dresser, cupboard, service desk)
Levidiotou S/2002	Non-case-control study	Environmental contamination (trunking)
Das I/2002	Non-case-control study	Environmental contamination (bed surfaces, surfaces of equipment, dried floor mops and curtains)
Jeena P/2001	Non-case-control study	Environmental contamination (ventilator dials, table surfaces, catheter suction tubing and telephones in the duty room)
Roberts SA/2001	Non-case-control study	Environmental contamination (door handle, ventilator control device, support stands and hands of healthcare workers)
Pillay T/1999	Non-case-control study	Environmental contamination (surface of a laryngoscope, suction bottles and catheters)
Cox MT/1998	Non-case-control study	Environmental contamination (sinks)
Go ES/1994	Non-case-control study	Environmental contamination (beds, tables, intravenous drip supports, ventilators and personnel hands)
Tankovic J/1994	Non-case-control study	Environmental contamination (sinks, furniture, gowns, windowsills)
Ahmed J/1994	Non-case-control study	Environmental contamination (peak flow meter)
Cefai C/1990	Non-case-control study	Environmental contamination (ventilator tubing)
Allen KD/1987	Non-case-control study	Environmental contamination (bed linen, curtains, mattresses, lamp, hands of healthcare workers)
Stone JW/1986	Non-case-control study	Environmental contamination (“Ambu” resuscitation device)
Number of environmental AB isolates		
Marchaim D/2007	Retrospective analysis of prospectively collected data	In 65% of cases, quantification of transmission opportunities (TOPs) involving patients with the same clone is greater than the number of TOPs involving patients with different clones ($p = 0.01$).
Denton M/2004	Non-case-control study	Number of environmental AB isolates obtained during each monthly screening ($p = 0.004$)
Corbella X/2000	Case-control study	Admission into a ward with a high density of CR AB (RR 1.73; 95% CI 1.21–2.47)
D'Agata EM/2000	Case-control study, matched	Exposure to a significantly higher number of patients with MDR AB infections (OR 1.1; 95% CI 1.01–1.2; $p = 0.02$)
Mulin B/1995	Case-control study, prospective	Previous stay in a unit (OR 9.1; 95% CI 1.31–63.20)

Table S1. *Cont.*

Author/ Year	Study Design	Risk Factors
Previous faecal carriage		
Corbella X/2000	Case-control study	Previous fecal carriage of CR AB (RR 35.3; 95% CI 7.2–173.1)
Wisplinghoff H/1999	Case-control study, retrospective	Prior nosocomial colonization with AB at a distant site (OR 26.23; 95% CI 4.68–147)
(2) Antibiotic exposure		
previous exposure to antibacterial agent		
Zhang HM/2014	Non-case-control study	Previous antibacterial use
Ma MY/2013	Non-case-control study	Usage of broad-spectrum antibiotics (OR = 3.054, 95% CI 1.009–6.550, $p = 0.004$).
Jung JY/2010	Case-control study, retrospective	Prior antimicrobial therapy
Romanelli RM/2009	Case-control study	Carbapenem use showed a tendency towards a statistical association ($p = 0.07$)
Romanelli RM/2009	Case-control study	Third-generation cephalosporin use ($p = 0.09$)
Young LS/2007	Non-case-control study	Receipt of fluconazole(OR, 73.3; $p < 0.01$),
Young LS/2007	Non-case-control study	Receipt of levofloxacin(OR, 11.5; $p = 0.02$)
von Dolinger de Brito D/2006	Non-case-control study	Exposure to antibiotics
Garnacho-Monter J/2006	Case-control study, retrospective	Prior exposure to imipenem (OR 4; 95% CI 1.1–29.8)
del Mar Tomas M/2005	Case-control study	Previous treatment with third-generation cephalosporins (OR 10; 95% CI 1.1–92.2)
Carbonne A/2005	Case-control study	Previous treatment with third-generation cephalosporins (OR 10; 95% CI 1.1–92.2)
Abbo A/2005	Case-control study, matched	Prior treatment with antimicrobial drugs (particularly metronidazole) (OR 4.74; 95% CI 1.31–17.15)
Nseir S/2005	Case-control study, prospective	Fluoroquinolone use (OR 3.3; 95% CI 1.7–6.5)
Lee SO/2004	Case-control study	Prior exposure to imipenem (OR 9.18; 95% CI 3.99–21.13)
Lee SO/2004	Case-control study	Prior exposure to third-generation cephalosporins (OR 2.11; 95% CI 1.13–3.95)
Smolyakov R/2003	Case-control study	Prior aminoglycoside therapy ($p = 0.003$)
Mahgoub S/2002	Case-control study, retrospective	Prior antibiotic use ($p = 0.035$)
Hsueh PR/2002	Non-case-control study	Use of carbapenems
Hsueh PR/2002	Non-case-control study	Use of ciprofloxacin

Table S1. *Cont.*

Author/Year	Study Design	Risk Factors
Chen CH/2002	Case-control study, retrospective	Administration of broad-spectrum antimicrobial agents ($p < 0.05$)
Landman D/2002	Non-case-control study	Cephalosporin use at each hospital ($p = 0.004$)
Jeena P/2001	Non-case-control study	Prior use of broad-spectrum antimicrobial agents
Manikal VM/2001	Non-case-control study	Use of third-generation cephalosporins ($p = 0.03$)
D'Agata EM/2000	Case-control study, retrospective	Administration of broad-spectrum antimicrobial agents
Husni RN/1999	Case-control study, retrospective	Prior use of ceftazidime ($p < 0.01$)
Spanik S/1999	Case-control study	Previous prophylaxis with ofloxacin ($p < 0.05$)
Spanik S/1999	Case-control study	Prior therapy with first-generation($p < 0.05$)
Spanik S/1999	Case-control study	Prior therapy with second-generation ($p < 0.05$)
Spanik S/1999	Case-control study	Prior therapy with third-generation cephalosporins ($p < 0.01$)
Spanik S/1999	Case-control study	Prior use of ceftazidime (OR 6; 95% CI 1.1–35)
Spanik S/1999	Case-control study	Prior therapy with aminoglycosides ($p < 0.01$)
Spanik S/1999	Case-control study	Prior therapy with imipenem ($p < 0.001$)
Koeleman JG/1997	Case-control study	Treatment with broad-spectrum antibiotics (OR 4.3; 95% CI 1.0–18.1)
Levin AS/1996	Case-control study	Number of antecedent antibacterials ($p = 0.025$)
Scerpella EG/1995	Case-control study	Use of third-generation cephalosporin ($p < 0.05$)
Peacock Jr JE/1981	Case-control study	Prior therapy with cephalosporins ($p = 0.018$)
Peacock Jr JE/1981	Case-control study	Prior therapy with aminoglycosides ($p = 0.08$)
Go ES/1994	Non-case-control study	Use of imipenem
Struelens M/1993	Case-control study, retrospective	Administration of broad-spectrum antimicrobial agents

Table S1. *Cont.*

Author/Year	Study Design	Risk Factors
(3) Host		
Longer duration of antibiotic treatment		
Nseir S/2005	Case-control study, prospective	Longer duration of antibiotic treatment (OR 1.1; 95% CI 1.0–1.2/day)
imipenem as monotherapy		
del Mar Tomas M/2005	Case-control study	Administration of imipenem as monotherapy (OR 11.12; 95% CI 2.33–53.09)
mechanical ventilation , and respiratory failure		
Ma MY/2013	Non-case-control study	Mechanical ventilation (odds ratio (OR) = 2.957, 95%confidence interval (95% CI) 1.106–6.253, $p = 0.023$)
Jung JY/2010	Case-control study, prospective	Respiratory failure at the time of ICU admission
Jung JY/2010	Case-control study, prospective	Maintenance of mechanical ventilation
Romanelli RM/2009	Case-control study	Mechanical ventilation use ($p = 0.003$)
Young LS/2007	Non-case-control study	Duration of intubation(OR, 1.4 per day intubated; $p < 0.01$)
Abbo A/2005	Case-control study, matched	Mechanical ventilation (OR 6.27; 95% CI 2.27–17.33)
Maslow JN/2005	Case-control study, prospective	Mechanical ventilation ($p < 0.001$)
Simor AE/2002	Case-control study	Mechanical ventilation (OR 1.1/day; 95% CI 1.0–1.1)
Mahgoub S/2002	Case-control study, retrospective	Mechanical ventilation ($p < 0.001$)
Corbella X/2000	Case-control study	Previous therapy with carbapenems (RR 4.58; 95% CI 1.34–15.6)
Cox MT/1998	Non-case-control study	Mechanical ventilation ($p < 0.05$)
Baraibar J/1997	Case-control study, prospective	ARDS (OR 9.73; 95% CI 1.60–59.24)
Levin AS/1996	Case-control study	Intubation ($p = 0.049$)
Struelens M/1993	Case-control study, retrospective	Mechanical ventilation
Beck-Sague CM/1990	Case-control study	Mechanical ventilation ($p = 0.0113$)

Table S1. *Cont.*

Author/Year	Study Design	Risk Factors
Pulmonary aspiration event		
Jung JY/2010	Case-control study, prospective	Maintenance of endotracheal tube instead of switching to a tracheostomy
Baraibar J/1997	Case-control study, prospective	Pulmonary aspiration (OR 2.90; 95% CI 0.80–10.53)
duration of ICU stay		
Ma MY/2013	Non-case-control study	ICU stay time ≥ 7 days (OR = 2.991, 95% CI 1.135–6.544, $p = 0.022$)
Maslow JN/2005	Case-control study, prospective	ICU admission ($p < 0.001$)
Lee SO/2004	Case-control study	ICU stay (OR 21.54; 95% CI 10.73–43.23)
Smolyakov R/2003	Case-control study	ICU admission ($p < 0.0001$)
Koeleman JG/1997	Case-control study	Prior ICU stay ($p = 0.002$)
Mulin B/1995	Case-control study, prospective	Longer ICU stay before colonization (OR 1.23; 95% CI 1.12–1.35)
Scerpella EG/1995	Case-control study	Longer duration of ICU stays ($p < 0.05$)
Peacock Jr JE/1981	Case-control study	Length of ICU stay ($p = 0.002$)
duration of hospitalization		
von Dolinger de Brito D/2008	Non-case-control study	Duration of hospitalization > or = 7 days
Maslow JN/2005	Case-control study, prospective	Total hospital days ($p < 0.001$)
Koeleman JG/1997	Case-control study	Length of stay >7 days (OR 5.3; 95% CI 1.3–22.6)
Scerpella EG/1995	Case-control study	longer duration of hospital stays ($p < 0.05$)
Prior hospitalization		
Mahgoub S/2002	Case-control study, retrospective	Prior hospitalization ($p = 0.014$)
invasive procedures , intervention		
Xia Y/2012	Case-control study	exposure to bronchoscopy (OR, 22.5; 95% CI, 2.07–244.84; $p = 0.005$)
Jung JY/2010	Case-control study, prospective	recent central venous catheter insertion
Romanelli RM/2009	Case-control study	central venous catheter use ($p = 0.04$).

Table S1. *Cont.*

Author/Year	Study Design	Risk Factors
Young LS/2007	Non-case-control study	exposure to bronchoscopy (OR, 22.7; $p = 0.03$),
von Dolinger de Brito D/2006	Non-case-control study	exposure to invasive devices
del Mar Tomas M/2005	Case-control study	Arterial catheter (OR 1.13; 95% CI 1.03–1.25)
Maslow JN/2005	Case-control study, prospective	Central venous catheterization ($p < 0.001$)
Wong H/2002	Case-control study, retrospective	Number of intravascular lines placed ($p < 0.05$)
Mahgoub S/2002	Case-control study, retrospective	Foley catheter ($p < 0.001$)
Mahgoub S/2002	Case-control study, retrospective	Tracheostomy ($p = 0.001$)
Receipt of blood products		
Simor AE/2002	Case-control study	Receipt of blood products (OR 10.8; 95% CI 3.4–34.4)
Hyperalimentation		
Mulin B/1995	Case-control study, prospective	Enteral hyperalimentation (OR 7.47; 95% CI 1.36–40.95)
Beck-Sague CM/1990	Case-control study	Hyperalimentation ($p = 0.018$)
pressure transducers		
Beck-Sague CM/1990	Case-control study	Duration of transducer use at an insertion site (in days) ($p = 0.0064$)
hydrotherapy		
Simor AE/2002	Case-control study	Procedures performed in the hydrotherapy room (OR 4.1; 95% CI 1.3–13.1)
Wisplinghoff H/1999	Case-control study, retrospective	Use of hydrotherapy (OR 5.5; 95% CI 1.11–27.76)
respiratory therapy		
Peacock Jr JE/1981	Case-control study	Prolonged respiratory therapy ($p = 0.006$)
Operation		
Katsaragakis S/2005	Case-control study, prospective	reoperation ($p = 0.01$; OR, 8.45; 95% CI, 1.52–46.85)
Borgmann S/2004	Non-case-control study	Surgery in a specific operation theatre where contaminated surgery class IV (infected, dirty) was performed

Table S1. *Cont.*

Author/Year	Study Design	Risk Factors
Koeleman JG/1997	Case-control study	Surgery ($p = 0.017$)
Baraibar J/1997	Case-control study, prospective	Neurosurgery (OR 10.03; 95% CI 1.55–64.90)
Baraibar J/1997	Case-control study, prospective	Head trauma (OR 5.17; 95% CI 0.88–30.34)
Gender		
Abbo A/2005	Case-control study, matched	Male sex (OR 3.84; 95% CI 1.63–8.99)
Wisplinghoff H/1999	Case-control study, retrospective	Female sex (OR 5.13; 95% CI 1.20–21.83)
Mulin D/1995	Case-control study, prospective	Male sex (OR 2.95; 95% CI 1.00–8.96)
age		
Lee SO/2004	Case-control study	Age (OR 1.03; 95% CI 1.01–1.05)
Melamed/2003	Non-case-control study	Younger age
Immune status		
Zhang HM/2014		non-case-control study
bacteremia with other than *A. baumannii* micro-organism		
Jung JY/2010	Case-control study, prospective	Bacteremia caused by other microorganism after colonization by MDR AB
previous septic shock		
Katsaragakis S/2005	Case-control study, prospective	Previous septic shock ($p = 0.04$; odds ratio (OR), 9.83; 95% confidence interval (CI), 1.003–96.29)
Low birth weight		
von Dolinger de Brito D/2007	Non-case-control study	Birth weight <1500 g, age < or = 7 days
Melamed R/2003	Non-case-control study	Lower birthweights
Conscious change		
Ma MY/2013	Non-case-control study	Coma (GCS < 8,OR = 2.894, 95% CI 1.803–7.462, $p = 0.010$)

Table S1. *Cont.*

Author/Year	Study Design	Risk Factors
Cardiopulmonary disease		
Young LS/2007	Non-case-control study	Presence of chronic pulmonary disease (OR, 77.7; $p = 0.02$)
Abbo A/2005	Case-control study, matched	Cardiovascular disease (OR 3.35; 95% CI 1.44–7.77)
wound care		
Maragakis LL/2004	Case-control study	Pulsatile lavage wound care (OR 36; 95% CI 2.8–1721)
Koeleman JG/1997	Case-control study	Wounds ($p = 0.044$)
Nursing home		
Maragakis LL/2004	Case-control study	Nursing home residence (OR 36; 95% CI 2.2–1833)
Mahgoub S/2002	Case-control study, retrospective	Nursing home residency ($p = 0.001$)
Time from admission to positive-culture date		
Lee SO/2004	Case-control study	Time from admission to positive-culture date (OR 1.02; 95% CI 1.002–1.03)
Burn		
Wisplinghoff H/1999	Case-control study, retrospective	Total body surface area burn of >50% (OR 6.13; 95% CI 1.21–37.80)
Presence of infection at admission		
Romanelli RM/2009	Case-control study	Prior infection ($p = 0.002$)
Lortholary O/1995	Case-control study, prospective	Presence of infection at admission ($p < 0.001$)
greater disease severity		
Young LS/2007	Non-case-control study	Higher Acute Physiology and Chronic Health Evaluation II score (odds ratio (OR), 1.1 per point increase; $p = 0.06$),
Brahmi N/2007	Case-control study, retrospective	Simplified Acute Physiological Score (SAPS II)
Wong H/2002	Case-control study, retrospective	APACHE II score on admission ($p < 0.05$)
Fierobe L/2001	Case-control study	High individual therapeutic intervention score (OR 2.67; 95% CI 0.99–7.22)
Lortholary O/1995	Case-control study, prospective	APACHE II score ($p < 0.05$)

Abbreviation: TOPs = quantification of transmission opportunities Study; SAPSII = Simplified Acute Physiological Score; OR = odds ratio; CI = confidence interval.

Table S2. Summary of infection control measures directed against the *A. baumannii* outbreak and cluster.

Authors/Year	Control Measures Directed Against the Source	Source/Predominant Involved Sites
Outbreak (or Clusters) with an identified common source		
Alfandari S/2014	Strict isolation precautions, staff and patient cohorting, and extensive environmental decontamination	blood pressure cuffs Velcro/NM
Xia Y/2012	Appropriate bronchofiberscope reprocessing and environmental decontamination	Bronchofiberoscopy/NM
Wroblewska MM/2004	NM	suctioning equipment/CSF
Melamed R/2003	Discontinuing the use of the bandages	hygroscopic bandages/soft tissue
Kappstein I/2000	Water taps and aerators removed and replaced, reinforcement of hand antisepsis and judicious use of gloving	Water taps in staff room with mesh aerators/Blood
Pillay T/1999	New suction catheter for each neonate, short-term unit closure, cohorting staff, hand hygiene	Suction catheter and bottle/NM
Yoo JH/1999	Replacement of ventilators	"Y" piece of ventilator/NM
Bellamore E/1997	New acetylcysteine nebulizer for each patient, enforcement of proper handling of multidose vials	Multidose acetyl- cysteine nebulization to multiple patients (presumed)/NM
Snelling AM/1996	Sterilization of probes with H_2O_2 free radicals	Temperature probe of ventilator humidifier/NM
Kaul R/1996	Ethylene oxide terminal sterilization of temperature probes, hand washing, cohorting culture-positive patients, separation of clean and dirty areas in respiratory therapy department	Ventilator temperature probes/NM
Weernink A/1995	Elimination of feather pillows, switch to synthetic pillows, washing pillows at 85 ºC	Feather pillows washed at low temperature/Soft tissue
Ahmed J/1994	High-level glutaraldehyde disinfection of flow meter, use of disposable mouthpiece, hand washing	Peak flow meter/NM
Cefai C/1990	Use of disposable ventilator tubing	Reusable ventilator tubing and humidifier/NM
Contant/1990	Ethylene oxide sterilization of probes or discard after use	In-line temperature and oxygen monitor probes/NM

Table S2. *Cont.*

Authors/Year	Control Measures Directed Against the Source	Source/Predominant Involved Sites
Beck-Sague CM/1990	Ethylene oxide terminal sterilization of pressure transducers between patients	Reusable pressure transducers in arterial lines/Blood
Ng PC/1989	NM	IV nutrition fluids (presumed)/Blood
Kelkar R/1989	Sterile disposable needles for methotrexate reconstitution	Multidose methotrexate and attached aspirating needle (presumed)/CSF
Hartstein AI/1988	Ethylene oxide terminal sterilization of circuits and resuscitation bags, disposable gloves used for final packaging of sterilized circuits and bags	Reusable ventilator circuits and resuscitation bags/NM
Vandenbroucke-Grauls CM/1988	Filters placed at end of inspiratory and expiratory tubing with technical modification of ventilator	Demand valve reservoir of ventilator/NM
Stone JW/1986	Sterilization of resuscitator bags after use	Mouthpiece of resuscitator bag/NM
Sherertz RJ/1985	Discard mattresses	Patient mattresses/Wound
Gervich DH/1985	Removal of humidifiers	Bedside humidifiers/Blood
Kantor RJ/1983	Discard diluted heparin after each shift	Heparinized saline solution/soft tissue
Irwin RS/1980	Removal of all spirometers, sterile gloves for patient contact, strict hand washing	Ventilator spirometers/NM
Cunha BA/1980	Restrict use of each respirometer to a single unit, volume measurements done at most distal portion of tubing, enforced and observed strict hand washing	Wright respirometers/NM
Reyes MP/1980	Ethylene oxide sterilization of distilled water catheters, no distilled water to rinse catheters	Hospital-prepared distilled water/soft tissue
Lowes JA/1980	Discontinuing use of malfunctioning bedpan washer, 1% hypochlorite disinfection of washed jugs followed by drainage	Bedpan and urine jugs/Urine
Abrutyn E/1978	Autoclaving the baths, disinfection of heating elements after each use, drying of dialysis fluid bottles after removal from bath	Warming bath water/Dialysis drainage fliud
Smith PW/1977	Removal of humidifiers	Bedside humidifiers/Blood

Table S2. *Cont.*

Authors/Year	Control Measures Directed Against the Source	Source/Predominant Involved Sites
	Outbreak (or Clusters) without an identified common source	
Authors/Year	Control measures directed against the source (initial/advanced measures)	Source
Liu WL/2014	preparation of disinfectants to adequately achieve environmental disinfection	NICS
Chen CH/2013	NM/environmental disinfection	NICS
Apisarnthanarak A/2012	NM/Environmental cleaning, contact isolation for patients, hand hygiene	NICS
Chmielarczyk A/2012	NM/strict isolation, education of staff, hand hygiene and surface decontamination by vaporized hydrogen peroxide	NICS
Hosoglu S/2012	NM/environmental disinfection	NICS
Lin WR/2011	NM/Environmental cleaning, contact isolation for patients, hand hygiene	NICS
Choi WS/2010	NM/Environmental cleaning, contact isolation for patients, hand hygiene	NICS
La Forgia C/2010	NM/Environmental cleaning, contact isolation for patients, hand hygiene	NICS
Ray A/2010	NM/strict isolation, education of staff, hand hygiene and surface decontamination by vaporized hydrogen peroxide	NICS
Chan PC/2007	NM/contact isolation, reinforcing hand hygiene adherence, cohorting of nurses, and environmental cleaning	NICS
Wybo I/2007	NM/contact precautions , hand hygiene , adherence, cohorting of nurses, and environmental cleaning , active surveillance cultures , controlled prescription and restricted use of broad-spectrum antibiotics	NICS
Pimentel JD/2007	NM/Cleaning and environmental decontamination as well as staff education	NICS
El Shafie SS/2004	NM/hand hygiene practices, extensive environmental cleaning, a closed suctioning system, education and review of other infection-control practices	NICS
Wang SH/2003	NM/use of strict cohort nursing, hand hygiene environmental cleaning, and replacement of a dysfunctional high-efficiency particulate air filter	NICS

Table S2. *Cont.*

Authors/Year	Control Measures Directed Against the Source	Source/Predominant Involved Sites
Aygün G/2002	NM/Unit closure, barrier isolation, environmental disinfection	NICS
Simor AE/2002	NM/hand hygiene, strict patient isolation, meticulous environmental cleaning, and temporary closure of the unit	NICS
Fierobe L/2001	NM/reinforcement of barrier safety measures, limitation of the number of admissions, and thorough environmental	NICS
D'Agata EM/2000	NM/Contact isolation, surveillance cultures	NICS
Corbella X/2000	NM/Unit closure, barrier isolation, environmental disinfection, controlled antibiotic use (carbapenem)	NICS
Biendo M/1999	Cohorting and contact isolation for patients with active infection, chlorhexidine or iodine (4%) hand antisepsis/Unit closure and thorough environmental disinfection	NICS
Cox MT/1998	NM/Environmental disinfection, disposable ventilator circuits, improved hand washing and changing of gloves between patient	NICS
Marques MB/1997	Contact isolation/Education, monitoring, strict adherence to contact isolation	NICS
Riley TV/1996	Body substance isolation, alcohol chlorhexidine hand disinfection, cohort patients, controlled antibiotic use (gentamicin and third-generation cephalosporins) (These measures were initially successful but then there was failure of control.)	NICS
Scerpella EG/1995	NM/Cohort patients, cohort staff, contact isolation, phenol environmental disinfection, antibiotic use consultation	NICS
Crowe M/1995	NM/Unit closure, cohort patients, cohort staff, contact isolation, phenol environmental disinfection, alcohol chlorhexidine hand disinfection or alcohol hand rub	NICS
Tankovic J/1994	Unit closure, complete cleaning and disinfection, no transfer of known affected patients into unit	NICS
Go ES/1994	NM/Cohort patients, controlled antibiotic use (imipenem), monitor hand washing and glove changes, wound irrigation with polymyxin B	NICS

Table S2. *Cont.*

Authors/Year	Control Measures Directed Against the Source	Source/Predominant Involved Sites
Struelens MJ/1993	NM Contact isolation, alcohol hand antisepsis, sterilization of reusable ventilator tubing	NICS
Patterson J/1991	NM/Cohort patients, appropriate glove changing and hand washing between patients	NICS
Buisson Y/1990	NM/Controlled antibiotic use (amikacin), isolation of patients, hand washing	NICS
Allen KD/1987	Cohort patients alcoholic chlor-hexidine hand antisepsis/Unit closure, environmental disinfection, discharge all colonized patients	NICS
Carlquist JF/1982	NM/Strict isolation, antibacterial hand cleanser, environmental disinfection	NICS
Castle M/1978	NM/Cohort patients, alcohol swab disinfection of Wright respirometer after each use, decrease routine saline irrigation for tracheobronchial suction, use small rubber-stoppered vials of saline for irrigation and discard after 24 hours, discard irrigating syringe after each use	NICS

Abbreviations: aICU: adult intensive care units; CSF: Cerebrospinal fluid; mo: month; NICS: no identified common source; nICU: neonatal intensive care units; nm: no mention; sICU: surgical intensive care units.

Table S3. Infection prevention measures at Changhua Christian Hospital.

Hand Hygiene Champions and Antibiotics Control Program	Contents
Contact isolation	1. Implementation of enhanced contact isolation precautions (*i.e.*, strict adherence to hand hygiene before and after patient care and donning of clean gowns and gloves before patient care), 2. In addition, contact precautions and isolation were applied to every patient with a history of MDRAB colonization and infection who was re-admitted to CCH
Cohort	Placing MDRAB patients in single rooms or cohorting patients in open-structured units
Environmental cleaning	1. Twice-daily environmental cleaning with a phenolic or quaternary ammonium disinfectant-detergent, as appropriate 2. A strict environmental cleaning policy was implemented according to CDC recommendations ***[1]** for rooms and for any objects that potentially contacted colonized patients. Certain devices (e.g., sphygmomanometers and stethoscopes) were dedicated for use on source patients whenever possible and were retained inside the room

Table S3. *Cont.*

Hand Hygiene Champions and Antibiotics Control Program	Contents
Meeting	1. Regular weekly meetings were held with the staff (including physicians, nurses, physical therapists, and students) in affected areas. 2. In addition, the staff was periodically informed about the evolution of disease rates as part of the educational program
Strategy One: Systemic change for Antibiotics Control Program	1. The infection control team (ICT) in CCH comprised an infection-control doctor, a pharmacist, an infection-control nurse and a microbiological technologist, and this team was extensively involved in the implementation of antimicrobial stewardship for all inpatients receiving antibiotic injections 2. The roles of the ICT included a review of antimicrobial orders with respect to the usage, dose, isolated pathogens and site of infection for all inpatients receiving parenteral antibiotics as well as consultation with the physicians before prescription of antibiotics. 3. A review was performed when antibiotic injections were prescribed. 4. Patients receiving carbapenem or anti-MDRAB agents were reviewed every week to facilitate therapy de-escalation. 5. When inappropriate antibiotic use was observed, the ICT members contacted the prescribing physicians.
Strategy Two: Education and training for Antibiotics Control Program	1. Held education course every year to staffs for antimicrobial therapy such as the selection of antibiotics, dosage, treatment duration, and 3-day rule as well as to highlight examples of inappropriate antibiotic use
Strategy Three: Assessment and Feedback for Antibiotics Control Program	1. To establish hand evaluation mechanism for antimicrobial administration , and regular audits 2. The duration of antimicrobial administration was limited to 2 weeks, and the ICT members included a cautionary message in the electronic medical chart. And, prolonged use of antibiotic injections over 2 weeks was not regarded as inappropriate for patients with infective septic arthritis, endocarditis, lung abscess and osteomyelitis. The duration was independently evaluated by the infection-control doctor and the clinical pharmacist. 3. When the message cautioning against continued antibiotic use was not heeded, the ICT members asked the prescriber to stop or change the antibiotics. 4. The appropriateness of antimicrobial use was decided according to the Sanford guide to antimicrobial therapy [*2]. Appropriateness of the duration was also evaluated according to the Sanford guide to antimicrobial therapy. 5. To feedback the results to the colleague 6. To hold team STEPPS meetings to strength team cohesion and teach communication skills

Table S3. *Cont.*

Hand Hygiene Champions and Antibiotics Control Program	Contents
Strategy Four: Workplace marked for Antibiotics Control Program	1. Set computer screen saver and desktop to remind appropriate antimicrobial administration
Strategy Five: Creating a safety culture ethos hospital for Antibiotics Control Program	1. Encourage patients to participate, and teach patients to remind staff for inappropriate antimicrobial adverse effect before antimicrobial prescription
Strategy Two: Education and training for Hand Hygiene Champions	1. Hold education course for handle hand hygiene with a total of 140 sessions, and the total number of 8775 participates 2. Design hand-washing device to teach hand-washing techniques.
Strategy Four: Workplace marked for Hand Hygiene Champions	1. Set computer screen saver and desktop to remind to wash hands 2. Executive head for hands washing activity
Strategy Three: Assessment and Feedback for Hand Hygiene Champions	1. To establish hand hygiene evaluation mechanism, regular audits, and build compliance monitoring platform 2. To feedback the results to the colleague 3. To hold team STEPPS meetings to strength team cohesion and teach communication skills
Strategy Four: Workplace marked for Hand Hygiene Champions	1. Set computer screen saver and desktop to remind wash hands 2. Executive leadership for hands washing activity
Strategy Five: Creating a safety culture ethos hospital for Hand Hygiene Champions	1. Design Vital hand-wash routine 2. Encourage patients to participate, and teach patients to remind staff for washing their hands before patients care

Notes: *[1] Centers for Disease Control and Prevention. Guidelines for environmental infection control in health-care facilities: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC) MMWR. 2003; 52(RR10):1–48; *[2] Gilbert DN, Moellering RC, Eliopoulos GM, *et al*. The Sanford Guide to Antimicrobial Therapy. 39th edn. Vermont: Antimicrobial Therapy; 2009.

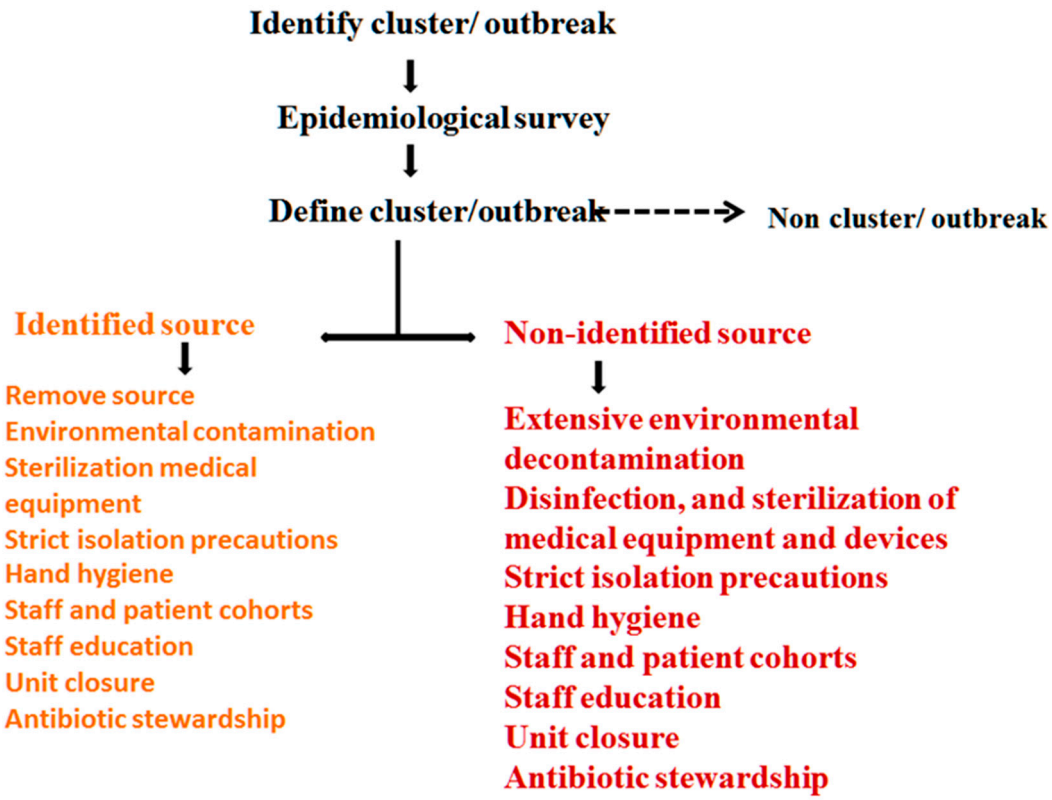

Figure S1. Process of cluster/outbreak at Changhua Christian Hospital.