Appendix 5: Characteristics of before-after studies (scoping review)

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
1	Abramczyk et al	2011	Preventing catheter-associated infections in the Pediatric Intensive Care Unit: impact of an educational program surveying policies for insertion and care of central venous catheters in a Brazilian teaching hospital	Before-After	Brazil	Urban	Pediatric patients	Patients in the pediatric ICU for more than 24 hours	All patients visiting the unit for more than 24hours during study period were enrolled	255 Patients	16 months	Tertiary - hospital	Educational program - Disinfection of hub connection

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
2	Allegranzi et al	2018	A multimodal infection control and patient safety intervention to reduce surgical site infections in Africa: a multicentre, before-after, cohort study	Before-After	Kenya, Uganda (two hospitals), Zambia, and Zimbabwe	Urban and Rural	All-age patients admitted to the HCF for a major operation	Patients receiving major elective and emergency operations in the HCFs were eligible for inclusion	Patients receiving major elective and emergency operations were eligible for inclusion	4 hospitals. 4322 operations were followed up (1604 at baseline, 1827 at follow-up, and 891 in the sustainability period)	30 months	Tertiary - hospital	Multimodal intervention including provision of antiseptics and education

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
3	Alp et al	2014	Evaluation of the effectiveness of an infection control program in adult intensive care units: a report from a middle-income country	ITS but data collected and analysed as a Before-After study	Turkey	Urban	Adults patients in the ICU	Patients in ICU	Patient records	Number of patients N/R 4 ICUs within 1 hospital	9 years (108 months)	Tertiary - hospital	Increased hand basins and alcohol-based hand rub availability phased in along with wider intervention bundle

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
4	Alvarez-Moreno et al	2016	Multicenter study in Colombia: Impact of a multidimensional International Nosocomial Infection Control Consortium (INICC) approach on central line-associated bloodstream infection rates	Before-After	Colombia	Urban	Pediatric and adult patients in the ICUs	Patients in adult ICU and patients in pediatric ICU	N/R	Total of 2,988 patients, hospitalized for 17,370 days, with a total of 13,263 CL days, at 4 hospitals in the following 3 types of ICUs: pediatric (n = 424), coronary (n = 373), and medical-surgical (n = 2,191)	83 months	Secondary/Tertiary - hospital	Multidimensional infection control approach

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
5	Apisarnthanarak et al	2014	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	Before-After	Thailand	Urban	All patients admitted to the medical ICU and intubated	All patients admitted to the medical ICU between May 1, 2011, and December 31, 2012 and intubated	All patients	1365 patients	30 months	Tertiary - hospital	Disinfection and hygiene among a larger intervention

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
6	Apisarnthanarak et al	2010	Effectiveness of a catheter-associated bloodstream infection bundle in a Thai tertiary care center: a 3-year study	Before-After	Thailand	Urban	All patients age 15 years or older who had a CVC	All consecutive patients age 15 years or older admitted to the hospital in all units between July 1, 2005, and June 30, 2008.	All hospitalized patients age 15 years or older who had a CVC were enrolled	3369 patients	36 months	Tertiary - hospital	Bundled infection control practices

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
7	Azab et al	2015	Reducing ventilator-associated pneumonia in neonatal intensive care unit using "VAP prevention Bundle": a cohort study	Before-After	Egypt	Urban	Neonates in the ICU	Neonates who had mechanical ventilation for ≥ 48 h	All patients included	143 patients	15 months	Tertiary - hospital	VAP prevention bundle

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
8	Guanche-Garcell	2013	Effectiveness of a multidimensional approach for the prevention of ventilator-associated pneumonia in an adult intensive care unit in Cuba: findings of the International Nosocomial Infection Control Consortium (INICC)	Before-After	Cuba	Urban	Adult patients in ICU	Adult patients on mechanical ventilation in ICU	All adult patients on mechanical ventilation in ICU at time of the study	1075 patients	50 months	Secondary/Tertiary - hospital	Bundle of Infection control measures

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
9	Jagi et al	2013	Impact of an international nosocomial infection control consortium multidimensional approach on central line-associated bloodstream infection rates in adult intensive care units in eight cities in India	Before-After	India	Urban	Adults in ICUs	Adults in the ICU	All ICU hospital patients	35650 patients	126 months	Secondary/Tertiary - hospital	Hand hygiene, disinfecting skin and medical equipment among a wider intervention

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
10	Kurlat et al	1998	Infection control strategies in a neonatal intensive care unit in Argentina	Before-After	Argentina	Urban	Neonates in ICU	Neonatal intensive care unit patients	All patients admitted to the NICU during study period	725 neonates at baseline 728 neonates end line	24 months	Tertiary - hospital	Guidelines created and staff trained in guidelines which include handwashing and sterilization
11	Leblebicioglu et al	2013	Impact of a multidimensional infection control approach on catheter-associated urinary tract infection rates in adult intensive care units in 10 cities of Turkey: International Nosocomial Infection Control Consortium findings (INICC)	Before-After	Turkey	Urban	All patients in ICU	Patients in ICU	All ICU patients in the hospitals during study period	4231 patients in 13 ICUs in 10 hospitals across 10 cities	82 months	Secondary/Tertiary - hospital	Mixed approach including hand hygiene and sterilization of equipment

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
12	Leblebicioglu et al	2013	Impact of a multidimensional infection control approach on central line-associated bloodstream infections rates in adult intensive care units of 8 cities of Turkey: findings of the International Nosocomial Infection Control Consortium (INICC)	Before-After	Turkey	Urban	Adult patients in ICU	Patients in ICU	All ICU adult patients in participating hospitals	4017 patients in 13 ICUs across 13 hospitals	76 months	Secondary/Tertiary - hospital	Mixed approach including hand hygiene and sterilization of equipment

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
13	Leblebicioglu et al	2013	Effectiveness of a multidimensional approach for prevention of ventilator-associated pneumonia in 11 adult intensive care units from 10 cities of Turkey: findings of the International Nosocomial Infection Control Consortium (INICC)	Before-After	Turkey	Urban	Adult patients in ICU	Patients in ICU	All ICU adult patients in participating hospitals	4312 across 11 adult ICUs from 10 hospitals	64 months	Secondary/Tertiary - hospital	Mixed approach including hand hygiene and sterilization of equipment

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
14	Lenz et al	2018	Impact of a program aimed at reducing catheter-related infections implemented in nine pediatric intensive care units in Argentina	Before-After	Argentina	Urban	Pediatric patients in ICU	Pediatric patients who had a central venous catheter during hospitalization	All patients in the pediatric ICUs. PICUs were selected from public hospitals based on their prior participation in a quality improvement program that had been implemented within 3 years earlier and their compliance with implementation and recording feasibility requirements	9 PICUs across 7 hospitals	11 months	Secondary/Tertiary - hospital	A bundle of measures based on health care staff training on catheter insertion, hand hygiene, and checklists

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
15	Marra et al	2010	Impact of a program to prevent central line-associated bloodstream infection in the zero tolerance era	Before-After	Brazil	Urban	All patients in the ICU and SDU (step-down units)	All ICU and SDU (step-down units) patients requiring central venous lines	All patients in the ICUs, SDUs during study period	Total patient days = 99,165 days	48 months	Tertiary - hospital	Intervention bundle including hand hygiene and sterilization
16	Mehta et al	2013	Effectiveness of a multidimensional approach for prevention of ventilator-associated pneumonia in 21 adult intensive-care units from 10 cities in India: findings of the International Nosocomial Infection Control Consortium (INICC)	Before-After	India	Urban	Adult patients in ICU	Adult patients in ICU	All ICU adult patients at time of study	46,954 patients from 21 ICUs from 14 hospitals	87 months	Secondary/Tertiary - hospital	Bundle which included adherence to hand hygiene (HH) guidelines and oral care with antiseptic solution among many others

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
17	Murni et al	2015	Reducing hospital-acquired infections and improving the rational use of antibiotics in a developing country: an effectiveness study	Before-After	Indonesia	Urban	Pediatric patients in the ICU and pediatric ward	Pediatric patients who were expected to remain in the pediatric wards or pediatric ICU for more than 48 h	All children admitted to the pediatric intensive care unit and pediatric wards were observed	1 hospital, 2646 patients	27 months	Tertiary - hospital	Multifaceted intervention including hand hygiene

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
18	Navoa et al	2013	Impact of an International Nosocomial Infection Control Consortium multidimensional approach on catheter-associated urinary tract infections in adult intensive care units in the Philippines: International Nosocomial Infection Control Consortium (INICC) findings	Before-After	Philippines	Urban	Adults in ICUs	Adults in ICU	All patients in ICU during study period	3183 patients hospitalized in 4 ICUS in 2 hospitals	60 months	Secondary/Tertiary - hospital	Multidimensional approach including hand hygiene sterilization guidelines among other measures

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
19	Ng Y.Y et al	2015	Impact of infection control training for interns on PICU-acquired bloodstream infections in a middle-income country	ITS but data collected and analyzed as a Before-After study	Malaysia	Urban	Pediatric patients in ICU	Pediatric patients admitted to the ICU between 1 January 2008 and 31 December 2009	All patients admitted to ICU during study period	721 PICU patients. 1 medical centre	24 months	Tertiary - hospital	Training in hand hygiene and aseptic techniques for accessing vascular catheters

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
20	Ogwang et al	2013	Prevalence of hospital-associated infections can be decreased effectively in developing countries	Before-After	Uganda	Urban	All patients in acute care unit (ACU)	All patients in ACU admitted to hospital not less than two days before the survey were eligible to participate in the prevalence survey.	Eligible patients were identified by examining inpatient medical charts	728 patients, 1 hospital	20 months	Tertiary - hospital	Infection control Programme including hand hygiene, disinfection of skin, etc.

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
21	Rosenthal et al	2006	Impact of an infection control program on rates of ventilator-associated pneumonia in intensive care units in 2 Argentinean hospitals	Before-After	Argentina	Urban	Adult patients in ICU and on mechanical ventilation	All adult patients who received MV for at least 24 hours	All eligible patients who were admitted to the study units	801 patients in 4 ICUs in 2 hospitals	24 months	Tertiary - hospital	Multi-component Infection control programme
22	Rosenthal et al	2005	Reduction in nosocomial infection with improved hand hygiene in intensive care units of a tertiary care hospital in Argentina	Before-After	Argentina	Urban	All patients in ICUs	All patients in ICUs	All patients in ICUs during study period	9596 bed days 2 ICUs, 1 hospital *number of patients not given	21 months	Tertiary - hospital	Hand hygiene

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
23	Rosenthal et al	2012	Impact of a multidimensional infection control strategy on central line-associated bloodstream infection rates in pediatric intensive care units of five developing countries: findings of the International Nosocomial Infection Control Consortium (INICC)	Before-After	Colombia, India, Mexico, Philippines and Turkey	Urban	Pediatric patients in ICUs	Pediatric patients in ICU	All eligible patients during study period	1,986 patients 9 PICUs in 9 hospitals	87 months	Secondary/Tertiary - hospital	INICC multidimensional infection control program including hand hygiene and disinfection

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
24	Rosenthal et al	2012	Impact of a multidimensional infection control strategy on catheter-associated urinary tract infection rates in the adult intensive care units of 15 developing countries: findings of the International Nosocomial Infection Control Consortium (INICC)	Before-After	Argentina, Brazil, China, Colombia, Costa Rica, Cuba, India, Lebanon, Macedonia, Mexico, Morocco, Panama, Peru, Philippines, and Turkey.	Urban	Adult patients in ICU	Adult patients in ICU with a urinary catheter (UC)	All eligible patients in ICU during study period	56,429 patients 57 AICUs	131 months	Secondary/Tertiary - hospital	I"INICC multidimensional infection control program including hand hygiene and disinfection "

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
25	Von Dolinger de Brito et al	2007	Effect of neonatal intensive care unit environment on the incidence of hospital-acquired infection in neonates	Before-After	Brazil	Urban	Neonates in the ICU	N/R	N/R	1811 neonates	54 months	Tertiary - hospital	Refurbishment of wards - improved sink:cot ratios

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
26	Zhou et al	2015	Successful reduction in central line–associated bloodstream infections in a Chinese neonatal intensive care unit	Before-After	China	Urban	Neonates in the ICU	All newborn patients with central line in dwelling for >48 hours and who had been hospitalized in the NICU for >=5 days during the study period	All eligible newborns in NICU at time of study	171 newborns	36 months	Tertiary - hospital	infection prevention bundle - including hand hygiene and sterile practices

Study #	Author	Year	Title	Study design	Country	Urban/Rural	Study population	Population characteristics	Method of participant selection	Sample size	Study duration	Type of facility	Intervention
27	Zhou et al	2013	Efficacy of an infection control program in reducing ventilator-associated pneumonia in a Chinese neonatal intensive care unit	Before-After	China	Urban	Neonates in ICU	All neonates who received mechanical ventilation for at least 48 hours and were hospitalized in the NICU for >5 days during 3 epochs were included	All eligible neonates in NICU at time of study	491 neonate patients	36 months	Tertiary - hospital	Bundle of comprehensive preventive measures against VAP - including hand hygiene and disinfection training

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
1	Abramczyk et al	2011	Didactic lectures, totaling 6 hours, were given to physicians, fellows and nursing staff of the unit using a slide show. The most important messages were: (I) catheters should be inserted using maximal barrier recommendations; (II) all inserted catheters should be removed as soon as possible; (III) hub connection disinfection with 70% alcohol before and after manipulation; (IV) site insertion CVC should be protected with impermeable plastic during bath; (V) fundamental cooperation of all unit members. No preferential site of insertion was recommended.	Combined	Educational messages given - hub connection should be disinfected with 70% alcohol before and after manipulation	2 months	7 months	CVC-AI were defined according to the CDC criteria of 1988 Exit site infections were defined as erythema, tenderness, induration or purulence affecting 2 cm of the skin at the exit site of the catheter. Primary bloodstream infections were defined as bacteraemia (or fungaemia), for which there was no documented distal source, and included infections resulting from insertion of a central intravenous line. The infection was categorized either as microbiologically documented or as clinical sepsis. Infections were regarded as ICU acquired infections if they occurred during PICU stay or within 48 hours of discharge from the unit. The presence of bacteremia was defined as the isolation of a pathogen from a blood culture of a patient with symptoms suggestive of infection.

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
2	Allegranzi et al	2018	Provision of antiseptic soap to patients for bathing and educational intervention for hospital staff	Combined	Provision of antiseptic soap to patients for bathing; optimise patient skin preparation, including local production of alcohol-based and chlorhexidine-based skin disinfection product; optimise surgical hand preparation, including local production of alcohol-based hand rub product and appropriate rubbing technique. Educational intervention on these techniques for hospital staff	Ongoing	7-12 months	Surgical site infection (SSI) is defined according to the CDC-NHSN

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
3	Alp et al	2014	Audits and feedback introduced 2009, 2009- increased hand basins and alcohol-based hand rub availability 2011 - bundle strategy introduced	Combined	Audits and feedback introduced 2009, 2009- increased hand basins and alcohol-based hand rub availability 2011 - bundle strategy introduced (WASH components = distribution of chlorhexidine-containing soap, hand hygiene compliance audits, staff compliance feedback and daily chlorhexidine bathing of ICU patients)	Unclear: Audits and feedback - 2009 -2012 (3 years) Hand basins and alcohol rub - 2009-2012 = 3 years Bundle introduced 2011 = 1 year	0 months	Text refers to: Horan TC, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of health care associated infection and criteria for specific types of infections in the acute care setting. Am J Infect Control 2008;36:309-32

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
4	Alvarez-Moreno et al	2016	The INICC multidimensional approach and the ISOS, which included a bundle of 1) infection prevention practice interventions - guidelines (handwashing, sterilizing, etc.), education (on the guidelines including hand hygiene and sterilizing), outcome surveillance, process surveillance, feedback on CLABSI rates and consequences, and performance feedback of process surveillance	Combined	The INICC multidimensional approach and the ISOS, which included a bundle of 1) infection prevention practice interventions - guidelines (handwashing, sterilizing (use a chlorhexidine-based antiseptic for skin preparation), etc.), education (on the guidelines including hand hygiene and sterilizing), outcome surveillance, process surveillance, feedback on CLABSI rates and consequences, and performance feedback of process surveillance	Varies across hospitals 7 months - 19 months	N/R	Applied CDC-NHSN definitions for CLABSI published by the CDC-NSHN in 1991

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
5	Apisarnthanarak et al	2014	In P2 (intervention period), all P1 (baseline period) interventions were continued, but bleach was used to clean environmental surfaces (e.g., bed rails, sinks, overbed tables, infusion pumps, surrounding counter tops) twice daily, and advanced source control was introduced. Advanced source control consisted of bathing patients once daily with 2% chlorhexidine in aqueous solution and performing oral care 4 times daily with 2% chlorhexidine. All P2 interventions were continued during P3, except an appropriate detergent-disinfectant replaced bleach.	Combined	Hand and environmental cleaning with disinfectant, bathing patients with chlorhexidine, and performing oral cleaning with chlorhexidine. Hand hygiene promotion and monthly feedback on hand hygiene compliance	5.5 months	12.5 months	MDR A baumannii was defined as an A baumannii isolate that was resistant to any 3 of 5 classes of systemic antibiotics (cephalosporins, aztreonam, carbapenems, aminoglycosides, fluoroquinolones), whereas XDR A baumannii was defined as an A baumannii isolate that was resistant to all currently available systemic antibiotics (ie, cephalosporins, aztreonam, carbapenems, aminoglycosides, fluoroquinolones, and sulbactam), except polymyxin B or tigecycline. Nosocomial infections were defined using Centers for Disease Control and Prevention criteria MICU acquisition of an XDR A baumannii surveillance isolate was defined as detection of this microorganism by active surveillance culture >48 hours after MICU admission, following a negative active surveillance culture result at the time of MICU admission.

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
6	Apisarnthanarak et al	2010	Period 1 = baseline Period 2 , alcohol- based hand rub dispensers installed and the CA-BSI prevention bundle was implemented. Components of CA-BSI bundle included (1) hospital-wide HCW education on proper hand hygiene, (2) education of physicians on the use of maximum sterile barrier precautions during CVC insertion, (3) use of a chlorhexidine based skin preparation, (4) optimization of CVC insertion practices, (5) daily review of the need for CVC in each patient. The educational component was for medical staff and was repeated every 4 months. During period 3 an intensified hand hygiene intervention was introduced. This intervention included similar but continuous education on hand hygiene and the importance of complying with the CA-BSI bundle for all involved HCWs	Combined	Provision of alcohol-based hand rub dispensers, hand hygiene education, education on using sterile barrier precautions during CVC nsertion, skin preparation with chlorhexidine.	12 months (CABSI bundle) Followed by 12 months CABSI bundle with intensified hand hygiene intervention	Measures taken at 12 months and 24 months - intervention implemented throughout	The definition of CA-BSI definition used in this study was derived from Centers for Disease Control and Prevention (CDC) definitions.

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
7	Azab et al	2015	Routine infection control (hand hygiene, sterilization of equipment) Bundle included: - Head-of-bed elevation 300-450. - Re-enforcement of hand hygiene practice. - Sterile suction and handling of respiratory equipment. - Intubation, re-intubation and endotracheal tube (ETT) suction as strictly indicated by unit protocol. - Change ventilator circuit if visibly soiled or mechanically malfunctioning (document) - Proper timed mouth care with normal saline and suction of oro-pharyngeal secretion. - Daily evaluation for readiness for extubation to nasal continuous airway pressure (NCPAP) at morning round, and sedation vacation for sedated patient	Combined	Bundle - WASH components include: Reinforcing hand hygiene of medical staff, sterilization of equipment, mouth hygiene of patients.	6 months	Collected immediately after - 0 months	VAP

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
8	Guanche-Garcell	2013	Multidimensional approach included the following measures: a bundle of infection control interventions, education, outcome surveillance, process surveillance, feedback of VAP rates and performance feedback of infection control practices	Combined	Bundle included (among other measures): Performance of comprehensive regular oral care with an antiseptic solution, performance of direct observation of hand hygiene compliance, adherence to hand-hygiene guidelines	47 months	0 months	The INICC Surveillance Program applies the definitions for device associated infections (DAIs) developed by the U.S. Centers for Disease Control and Prevention (CDC) for the National Nosocomial Infection Surveillance System (NNIS)/National Health Safety Network (NHSN) program CDC NHSN definitions for VAP were applied whereby VAP is diagnosed in a mechanically ventilated patient with a chest radiograph showing new or progressive infiltrates, consolidation, cavitation, or pleural effusion. The patient also must meet at least one of the following criteria: new onset of purulent sputum or change in character of sputum; organism cultured from the blood; or isolation of an etiologic agent from a specimen obtained by tracheal aspirate, bronchial brushing or bronchoalveolar lavage, or biopsy

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
9	Jagi et al	2013	The International Nosocomial Infection Control Consortium (INICC) approach was implemented, which included a bundle of infection control interventions, education, outcome surveillance, process surveillance, feedback on CLABSI rates and consequences, and performance feedback	Combined	Bundle included hand hygiene, chlorhexidine for skin preparation, disinfecting medical equipment	ICUs had undergone different lengths of intervention. The average length of the intervention period was 17.54 months (standard deviation 8.9 months, range 5–36 months).	36 months	Definition from CDC/NHSN (US Centers for Disease Control and Prevention/ National Healthcare Safety Network)

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
10	Kurlat et al	1998	The intervention strategy was a three-step programme. Step 1 included surveillance of NICU practices to establish possible causes for high endemic infection rates. Step 2 was dedicated to the development of guidelines for those practices that were judged to be responsible for high infection rates. Guidelines for handwashing, infant handling and use of gloves, care of intravenous lines, including dressing and handling of three-way-stopcock, and suction of the endotracheal tube were established. Step 3 - training personnel in guidelines	Combined	Guidelines created and staff trained in guidelines which include handwashing and sterilization	12 months	0 months	N/R

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
11	Leblebicioglu et al	2013	a multidimensional approach that included bundle of infection control interventions, education, surveillance and feedback on CAUTI rates, process surveillance, and performance feedback.	Combined	HH before insertion and manipulation of the urinary catheter, disinfection of skin and equipment, monitoring/observation of hand hygiene compliance in HCWs	The average length of intervention was 22.4 months, standard deviation 17.2 (range, 4-60).	0 months	Definitions of the Centers for Disease Control and Prevention/National Healthcare Safety Network used

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
12	Leblebicioglu et al	2013	1- bundle of infection control interventions, 2- education, 3- outcome surveillance, 4- process surveillance, 5- feedback of CLAB rates, and 6- performance feedback on infection control practices.	Combined	Hand hygiene, disinfection of skin and equipment, daily bathing with chlorhexidine	The average length of the intervention period was 15.6 months ± SD 9.2 (range 4 – 36).	0 months	Definitions of the CDC/NHSN and INICC surveillance methods applied

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
13	Leblebicioglu et al	2013	1- Bundle of infection control interventions 2- education, 3- outcome surveillance, 4- process surveillance, 5- feedback of CLAB rates, and 6- performance feedback on infection control practices.	Combined	Hand hygiene, disinfection of skin and equipment, oral care with antiseptic solution, observation of HH compliance	The average length of the intervention period was 28.64 months ± SD 20.27 (range 6–72)	0 months	CDC NHSN definitions for VAP applied. VAP is diagnosed in a mechanically ventilated patient with a chest radiograph that shows new or progressive infiltrates, consolidation, cavitation, or pleural effusion. The patient also must meet at least one of the following criteria: new onset of purulent sputum or change in character of sputum, organism cultured from blood, or isolation of an etiologic agent from a specimen obtained by tracheal aspirate, bronchial brushing or bronchoalveolar lavage, or biopsy

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
14	Lenz et al	2018	Monthly workshops were carried out on hand hygiene and the implementation of the five moments at the point of patient care	Combined	Workshops were carried out on hand hygiene and the implementation of the five moments at the point of patient care	10 months	0 months	Definition from the Centers for Disease Control and Prevention (CDC)

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
15	Marra et al	2010	Bundle included creation of a central catheter insertion cart; hand hygiene; maximal barrier precautions for insertion; chlorhexidine skin antisepsis; optimal catheter site selection, with avoidance of the femoral vein for central venous access in adult patients; daily review of line necessity with prompt removal of unnecessary lines) The ICU and SDU nurses intervened in this process at the same time that performance monitoring was occurring at the bedside if non-compliance with an element of the bundle was detected (eg, hand hygiene was not performed).	Combined	Hand hygiene, disinfection of skin and equipment, monitoring of HH compliance	24 months	0 months	CDC definition A CLABSI was considered to be related to a specific unit if detected at least 48 hours after admission to, or less than 48 hours after discharge from, the unit

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
16	Mehta et al	2013	International Nosocomial Infection Control Consortium's (INICC) approach --> bundle of interventions, education, outcome and process surveillance, and feedback of VAP rates and performance.	Combined	Bundle which included adherence to HH guidelines and oral care with antiseptic solution	Average duration (±S.D.) of 23·33±16·86 (range 6–76) months	0 months	VAP was diagnosed in a mechanically ventilated patient when a chest radiograph showed new or progressive infiltrates, consolidation, cavitation, or pleural effusion. The patient also had to meet at least one of the following criteria: new onset of purulent sputum or change in character of sputum, organism cultured from blood, or isolation of an etiological agent from a specimen obtained by tracheal aspirate, bronchial brushing or bronchoalveolar lavage, or biopsy

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
17	Murni et al	2015	The multifaceted intervention consisted of a hand hygiene campaign, antibiotic stewardship and other elementary infection control practices. The intervention included educational seminars, reminders, audit and performance feedback	Combined	Hand hygiene education and reminder checklists	3 months	12 months	The definitions of HAI were based on the US Centers for Disease Control and Prevention (CDC), National Healthcare Safety Network and the National Nosocomial Infections Surveillance system.

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
18	Navoa et al	2013	INICC programme - a multidimensional approach that included: (1) a bundle of infection control interventions, (2) education, (3) surveillance of CAUTI rates, (4) feedback on CAUTI rates, (5) process surveillance and (6) performance feedback.	Combined	Hand hygiene education, sterilization of skin and equipment	The average length of the intervention period was 27.9 months ± 18.2 (SD; range 10—61)	0 months	Definition for healthcare-associated infections(HAIs) developed by the US Centers for Disease Control and Prevention (CDC) for the National Healthcare Safety Network (NHSN) program Definition of CAUTI: CAUTI was diagnosed if the patient met one of two criteria. The first criterion was satisfied when a patient with a urinary catheter had one or more of the following symptoms with no other recognized cause: fever (temperature ≥38◦C), urgency, or suprapubic tenderness. The urine culture was positive for 105 colony-forming units (CFU) per mL or more, with no more than two microorganisms isolated. The second criterion was satisfied when a patient with a urinary catheter had at least two of the following criteria with no other recognized cause: positive dipstick analysis for leukocyte esterase or nitrate and pyuria (≥10 leukocytes/mL)

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
19	Ng Y.Y et al	2015	All pediatric Interns trained on infection control - hand hygiene, disposal of fluids, gloves, sterilization, etc.	WASH only	Training on hand hygiene and aseptic technique for pediatric interns	2 months	0 months	ICU-associated infection was defined as an infection that was not present or incubating during the patient's admission to the ICU, but became apparent during the ICU stay or within 48 hours after transfer from the ICU A BSI was considered to have been acquired in the PICU if the positive blood culture was obtained more than 48 hours after the patient's admission to the unit.

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
20	Ogwang et al	2013	infection control programme - little info given	Combined	Hand hygiene and skin and equipment disinfection	12 months	0 months	The HAI definitions used were based on WHO simplified criteria for surveillance of nosocomial infections but only clinical criteria were used HAI was defined as an infection that was not present at hospital admission and occurred more than 48 h after admission

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
21	Rosenthal et al	2006	One-hour educational sessions. Each 1-hour session was self-contained and emphasized the following: (1) epidemiology and pathogenesis of nosocomial pneumonia; (2) hand hygiene before and after patient contact; (3) proper handling of the respiratory secretions and suction catheters; and (4) percussion and postural drainage to stimulate coughing Feedback of VAP rates was provided to ICU HCWs on a monthly basis	Combined	Hand hygiene education	24 months	0 months	Standard Centers for Disease Control and Prevention (CDC)/National Nosocomial Infection Surveillance (NNIS) system definition used

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
22	Rosenthal et al	2005	Interventions to improve hand hygiene compliance included monthly meetings at which visual displays of handwashing rates were presented. These were also posted monthly in the 2 ICUs. Focused education of all HCWs was provided. Educational classes were given in 1-hour group sessions for all shifts every day for 1 week. Each participant was given the infection control manual, and the APIC hand hygiene guideline was used as an educational tool to reinforce classroom teaching	WASH only	Hand hygiene education, visual displays of hand hygiene rates.	17 months	0 months	Adapted standard definitions of the Centers for Disease Control and Prevention

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
23	Rosenthal et al	2012	The INICC multidimensional infection control strategy includes the following: (1) bundle of infection control interventions, (2) education, (3) outcome surveillance, (4) process surveillance, (5) feedback of CLAB rates, and (6) performance feedback of infection control practices	Combined	Hand hygiene, disinfection of skin and equipment	The average length of the intervention period was 12.8 months ± standard deviation (SD) 8.9 (range 3–24)	0 months	Laboratory confirmed CLAB: A patient with a CL who has a recognized pathogen isolated from one or more percutaneous blood cultures after 48 h of catheterization; the pathogen cultured from blood is not related to an infection at another site; and a patient has one or more of the following signs or symptoms: fever (>= 38oC), chills, or hypotension. With skin commensals (diphtheroids, Bacillus spp., Propionibacterium spp., coagulase-negative staphylococci or micrococci), the organism has been recovered from two or more separate blood cultures Clinically confirmed CLAB: A patient with a CL who has at least one of the following clinical signs, with no other recognized cause: fever A patient with a central line who has at least one of the following clinical signs, with no other recognized cause: fever (>= 38oC), hypotension (systolic blood pressure (<= 90 mmHg), or oliguria (<=20 mL/h), but blood cultures were either not obtained or no organisms were recovered from blood cultures; there is no apparent infection at another site; and the physician instigates antimicrobial therapy, hypotension (systolic blood pressure 90 mmHg), or oliguria (B20 mL/h), but blood cultures were either not obtained or no organisms were recovered from blood cultures; there is no apparent infection at another site; and the physician instigates antimicrobial therapy

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
24	Rosenthal et al	2012	The INICC multidimensional infection control strategy includes the following: (1) bundle of infection control interventions, (2) education, (3) outcome surveillance, (4) process surveillance, (5) feedback of CLAB rates, and (6) performance feedback of infection control practices"	Combined	Hand hygiene, disinfection of skin and equipment, hand hygiene monitoring observations, HH compliance feedback	The average length of the intervention period was 22.9 months ± standard deviation (SD) 20.85 (range 4–107)	0 months	For the diagnosis of CAUTI, the patient must meet one of two criteria. The first criterion is satisfied when a patient with a UC has one or more of the following symptoms, with no other recognized cause: fever (temperature >=38 oC), urgency, or suprapubic tenderness. The urine culture is positive for 105 colony-forming units (CFU) per mL or more, with no more than two microorganisms isolated. The second criterion is satisfied when a patient with a UC has at least two of the following criteria, with no other recognized cause: positive dipstick analysis for leukocyte esterase or nitrate and pyuria (>= 10 leukocytes/ mL)

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
25	Von Dolinger de Brito et al	2007	From January to September 2003 the unit was refurbished and the design of the new facility was much more conducive to good infection control practices. Surveillance was performed over three different periods: (A) in the original facilities between January 2001 and December 2002; (B) in temporary accommodation from January to September 2003; (C) in the new unit between October 2003 and July 2005. The original (period A) and temporary (period B) units had smaller floor areas than the new (period C) unit with archaic ventilation systems, whereas the new unit had more space and central air conditioning. The average of admissions per month was highest (38 per month) in period B compared to 33 and 30 per month in periods A (P = 0.00002) and C (P = 0.0002) respectively. Though the number of nurses (N = 5) and cots (N = 10) remained the same throughout all periods, the ratio of NICU nurses to number of monthly admissions was lower in period B (P = 0.001). Sink:cot ratio was also lower in period B (0.1, P < 0.002) compared to 0.2 in A and 0.4 in C (Table I). In the new unit, four sinks were installed at the entrance with paper towels, automated faucet and dispensers of 2.0% chlorhexidine. In addition, the new unit had an isolation side-room, with a sink and automatic faucets	Combined	Refurbishment including - sinks, automated taps, paper towels and anti-microbial (chlorhexidine) dispensers	unclear	unclear	Infections that manifested with suggestive clinical symptoms and/or positive cultures 48 h or more after birth were defined as nosocomial infections, according to the definitions from NNISS

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
26	Zhou et al	2015	Medical and nursing staff asked to adhere to these measures: 1) Enhance hand hygiene practices 2) Establish dedicated PICC team and monitor group 3) Use an all-inclusive central line (CL) cart and prepackaged kits 4) Evaluate the CL daily and removal of nonessential CLs 5) Provide education and simulation training: hand hygiene, barrier precautions (sterile gown and gloves, cap, mask, and a large sheet) during CL insertion, and CL care and maintenance	Combined	Hand hygiene education, easily accessible hand washing and hand disinfection facilities, using sterile techniques	12 months	12 months	The Centers for Disease Control's National Healthcare Safety Network (NHSN) definitions were used to define CLABSI. CLABSI was considered if the central line was in use at the time of or during the 48 hours preceding the development of bloodstream infection.

Study #	Author	Year	Description of the intervention	WASH only/Combined	WASH intervention description	Length of the intervention	Length of post-intervention follow up	Definition of HCAI used
27	Zhou et al	2013	Phase 2 = Bundle included: 1) New unit - improved ventilation and patients were allocated to specific areas based on their diagnosis and clinical course 2) Reinforcement of hand hygiene practices 3) Rational waste disposal: Colored buckets were placed in the new ward. Black buckets for normal waste and yellow for potentially infectious or dangerous waste such as syringes, needles, and broken tubes 4) Enhancement of patient isolation and ventilator disinfection 5) Periodic educational activities on VAP prevention, including hand hygiene 6) Shorten duration of mechanical ventilation 7) Enhance the respiratory management of patients 8) Rational use of antibiotics Phase 3 = All the above measures for VAP control were continued through this phase. Additionally, NICU staff members, including nursing staff, were empowered to monitor and impede any breaches in infection control.	Combined	Reinforcement of hand hygiene practices, rational waste disposal (separating normal and infectious waste), ventilator disinfection, hand hygiene education	12 months	0 months	Diagnosis of VAP was based on modified criteria from published literature and from US Centers for Disease Control and Prevention11,12 and included infants who developed new and persistent radiographic evidence of focal infiltrates; had at least 3 clinical signs and symptoms, including temperature instability, wheezing, tachypnea, cough, abnormal heart rate, change in secretions, or an abnormal leukocyte count; received antibiotics for at least 7 days

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
1	Abramczyk et al	2011	Incidence of CVC-associated infections (CVC-AI): CVC-associated bloodstream infections (CVC-ABSI) CVC-site insertion CVC-AI	N/R	N/R	Bacteria cultures	The incidence density of catheter infections was 31.1 episodes per 1,000 venous central catheter-days before interventions and 16.5 episodes per 1,000 venous central catheter-days after interventions [RR 0.53 (95% CI 0.28-1.01)]. Corresponding rates for exit-site catheter infections were 8 and 2.5 episodes per 1,000 venous central catheter-days, respectively [0.32 (95% CI 0.07-1.49)], and the rates for bloodstream infections were 23.1 and 13.7 episodes per 1,000 venous central catheter-days, before and after intervention [0.61 (95% CI 0.32-1.14)].	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
2	Allegranzi et al	2018	SSI (first occurrence) - the cumulative incidence of SSI per 100 surgical operations within 30 days of the procedure.	Death within 30 days post surgery	Adherence to SSI prevention measures (prospectively collected)	N/R	SSI cumulative incidence significantly decreased post intervention, from 8·0% (95% CI 6·8–9·5; n=129) to 3·8% (3·0–4·8; n=70; p<0·0001), and this decrease persisted in the sustainability period (3·9%, 2·8–5·4; n=35) The likelihood of SSI during follow-up was significantly lower than pre-intervention (odds ratio [OR] 0·40, 95% CI 0·29–0·54; p<0·0001), but the likelihood of death was not significantly reduced (0·72, 0·42–1·24; p=0·2360).	Implementation of the Surgical Unit-based Safety Programme intervention was done entirely by local teams. Staff from WHO and Johns Hopkins Armstrong Institute for Patient Safety and Quality formed a central coordinating team that provided technical expertise and mentorship on project management and data collection. This central coordination was delivered at a distance through monthly webinars, e-mails, and telephone discussions, until the end of follow-up. During the study, each site received one support visit from the WHO team, and participated in three inter-site meetings. Between-site exchange of information was encouraged throughout the study. Authors believed that the success in the improvement of clinical practice and outcomes was mainly attributable to	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
								the motivation of site staff to improve their practices, and the status of local project leaders as influential members of their respective departments		

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
3	Alp et al	2014	HAIs per 1,000 patient-days Device utilization and device-associated infection rates per 100 patients Incidence of multi-resistant microorganisms (MROs)	N/R	Hand hygiene compliance	N/R	The HAI rate was 42.6/1,000 patient-days at baseline and increased significantly thereafter until 2012, when it decreased by 20% to 33.6/1,000 patient-days (IRR, 0.8; P = 0.001). The rate of central line-associated bloodstream infection was 7.85 (95% confidence interval [CI], 5.89-10.26)/1,000 catheter-days in 2004 and increased to 12.4 (95% CI, 9.98-14.39)/1,000 catheter-days in 2012 (IRR, 1.5; P 0..024). The rate of ventilator-associated pneumonia remained stable from the 2004 baseline rate of 31.66/1,000 ventilator-days to the 2012 rate of 24.04/ 1,000 ventilator-days (IRR, 0.88; P = 0.574). The rate of catheter-associated urinary tract infection remained relatively stable between 2004 and 2012 (from 7.92/1,000 catheter-days to 4.97/1,000 catheterdays; P = 0.101). The rate of methicillin-resistant Staphylococcus aureus infection was 6.24/1,000 patien tdays at baseline and decreased significantly to 0.73/1,000 patient-days by 2007 (IRR, 0.13; P <.001) and continued to remain below 2/1,000 patient-days for the next 5 years.	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
							The rate of Pseudomonas aeruginosa infection decreased significantly from 8.66/1,000 patient-days in 2004 to 6.09/1,000 patient-days in 2010 (IRR, 0.72; P = 0.026) and to 5.44/1,000 patient-days by 2012 (IRR, 0.63; P = 0.002). The rate of Acinetobacter baumannii infection was 14.3/1,000 patient-days at baseline, decreased significantly by 2005 (IRR, 0.73; P = 0.012), fluctuated between 2006 and 2010, and then decreased significantly to 10.44/1,000 patient days in 2011 (IRR, 0.74; P = 0.007) and then to 7.6/1,000 patient-days in 2012 (IRR, 0.53; P < .001).			

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
4	Alvarez-Moreno et al	2016	Central line–associated bloodstream infection (CLABSI)	N/R	N/R	N/R	The baseline rate of 12.9 CLABSIs per 1,000 central line (CL) days, with 3,032 CL days and 39 CLABSIs, was reduced to 3.5 CLABSIs per 1,000 CL days, with 3,686 CL days and 13 CLABSIs, accounting for a 73% CLABSI rate reduction (relative risk, 0.27; 95% confidence interval, 0.14-0.52; P=0.002).	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
5	Apisarnthanarak et al	2014	VAP CAUTI CLABSI *these were secondary outcomes in this study	Drug-resistant (XDR) Acinetobacter baumannii *though was the primary outcome of this study	N/R	Culture for XDR A baumannii Surveillance specimens were inoculated onto MacConkey agar with a 10-mg imipenem disk and incubated for up to 5 days	Compared with P1 (11.1 cases/1,000 patient-days), the rate of XDR A baumannii clinical isolates declined in P2 (1.74 cases/1,000 patient-days; P < .001) and further in P3 (12 month follow up period) (0.69 cases/1,000 patient-days; P < .001). Compared with P1 (12.15 cases/1,000 patient days), the rate of XDR A baumannii surveillance isolates also declined in P2 (2.11 cases/1,000 patient days; P < .001) and P3 (0.98 cases/1,000 patient-days; P < .001). Incidence of nosocomial infections remained stable. CLABSI rate P1 = 1.44, P2= 1.20, P3 = 1.14 (all NS) CAUTI rate P1 = 2.25, P2 = 1.96, P3 = 2.10 (all NS) VAP rate P1 = 4.12, P2 = 3.64, P3 = 2.98 (all NS)	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
6	Apisarnthanarak et al	2010	Catheter-associated bloodstream infection (CA-BSI)	Methicillin-resistant Staphylococcus aureus, coagulase negative Staphylococcus spp, extended-spectrum beta-lactamase (ESBL)-producing Escherichia coli and Klebsiella pneumoniae, and multidrug-resistant (MDR) Acinetobacter baumannii` Mortality	N/R	N/R	During period 2, the CA-BSI rate decreased by 54.1 % (6.4 cases per 1000 catheter-days; P ,.001). The CA-BSI rate was further decreased by 78% (1.4 cases per 1000 catheter-days; P ,.001) during period 3. Not significant change in mortality P1 = 12% P2 = 12% P3 = 13% (of patients)	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
7	Azab et al	2015	VAP	Mortality	N/R	The clinical microbiological laboratory analyzed the samples using Bact/Alert 3D-Biomerieux-France and provided microorganism identification followed by antibiotic sensitivity according to the isolate using Vitek MS – Biomerieux-France.	The rate of VAP was significantly reduced from 67.8 % (42/62) corresponding to 36.4 VAP episodes/1000 mechanical ventilation days (MV days) in phase-I to 38.2 % (31/81) corresponding to 23 VAP/1000 MV days (RR 0.565, 95 % confidence interval 0.408-0.782, p = 0.0006) after VAP prevention bundle implementation (phase-II). Overall mortality reduced from 25 % to 17.3 %, p = 0.215 between the two phases but didn't reach statistical significance.	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
8	Guanche-Garcell	2013	VAP: VAP rates per 1000 device-days	Mortality	Bacterial resistance, length of stay, microorganism profile, HH compliance	Cultures taken, none other specified	During baseline, the VAP rate was 52.63 VAPs per 1000 MV-days, whereas the VAP rate was 15.32 per 1000 MV days during intervention (RR 0.3; 95% CI 0.12—0.7; P 0.003). These results showed a 70% VAP rate reduction In comparison to the baseline VAP rates for the 3 months before the intervention, VAP rates were reduced by: 73% after 9 months of participation (from 52.63 to 14.36 VAPs per 1000 MV-days, RR = 0.27 (0.09—0.79) P= 0.0099) This rate was further reduced by 58% during the second year (from 52.63 to 22 VAPs per 1000 MV-days, RR = 0.42 (0.16—1.07) P= 0.0604), 75% during the third year (from 52.63 to 18.35 VAPs per 1000 MV-days RR = 0.35 (0.13—0.96) P = 0.0326) and 90% during the fourth year (from 52.63 to 5.34 VAPs per 1000 MV-days, RR = 0.10 (0.03—0.41) P = 0.0001)	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
9	Jagi et al	2013	Central line-associated bloodstream infections (CLABSI) Rates of CLABSI per 1000 CL days	N/R	Hand hygiene compliance (of staff)	Cultures. A laboratory confirmed CLABSI was defined in the following case: A patient with a CL from whom a recognized pathogen is isolated from one or more percutaneous blood cultures after 48 h of catheterization; the pathogen cultured from the blood is not related to an infection at another site; and the patient has one or more of the following signs or symptoms: fever (38 8C), chills, or hypotension	The baseline rate was 6.4 CLABSIs per 1000 CL-days, which was reduced to 3.9 CLABSIs per 1000 CL-days in the second year and maintained for 36 months of follow-up, accounting for a 53% CLABSI rate reduction (incidence rate ratio 0.47, 95% confidence interval 0.31–0.70; p = 0.0001)	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
10	Kurlat et al	1998	Overall rates of bacteraemia (BR) and rates of Gram negative bacteraemia (GNBR) calculated per 1000 patient-days	None	N/R	Blood cultures	Bacteraemia rate was 20/1000 patient days at baseline and dropped to 12.4 /1000 patient days after the intervention was introduced (p<0.004). The gram negative bacteramia rate was 7.7/1000 patient days at baseline and the dropped to 2.2/1000 patient days at end line, p<0.0002)	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
11	Leblebicioglu et al	2013	CAUTI rate	N/R	Hand hygiene compliance	Urine culture and dipstick analysis for leukocyte esterase or nitrate and pyuria	During Baseline, the rate of CAUTI was 10.63 per 1,000 UC-days and was significantly decreased by 47% at end line to 5.65 per 1,000 UC-days (relative risk, 0.53; 95% confidence interval: 0.4-0.7; P value ¼ .0001)		N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
12	Leblebicioglu et al	2013	Central line-associated blood stream infections (CLAB) rates	N/R	Hand hygiene compliance	Blood cultures	The baseline CLAB rate was 22.7 per 1000 CL days, which was decreased during the intervention period to 12.0 CLABs per 1000 CL days (IRR 0.613; 95% CI 0.43 – 0.87; P 0.007). This amounted to a 39% reduction in the incidence rate of CLAB.		N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
13	Leblebicioglu et al	2013	VAP	N/R	Hand hygiene compliance	Blood cultures	The rate of VAP was 31.14 per 1,000 MV-days during baseline period and 16.82 per 1,000 MV-days intervention period, amounting to a 46 % VAP rate reduction (RR, 0.54; 95 % CI, 0.42–0.7; P value, 0.0001.)	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
14	Lenz et al	2018	Catheter-related infections (CRIs) CRI rate per 1000 CVC days	N/R	Prevention (CDC), CVC use rate, adherence to hand washing, and adherence to CVC insertion control	N/R	The total number of CRIs was 117 and 74 before and after the intervention, respectively. The rate of CRIs was 8.6/1000 days of central venous catheter use and 5.8/1000 days before and after the intervention, respectively; RR: 0.82 (95% confidence interval: 0.68-0.98), p= 0.015	All staff members involved in patient care participated in the program, including technicians and cleaning staff, not only physicians and nurses	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
15	Marra et al	2010	Central line-associated bloodstream infection (CLABSI)	N/R	Device utilization ratio (calculated by dividing the catheter days by number of patient-days)	All isolates were identified by manual or automated methods and confirmed using the Vitek 2 system	The mean incidence density of CLABSI per 1000 catheter-days in the ICU was 6.4 in phase 1 and 3.2 in phase 2, P = 0.001. The mean incidence density of CLABSI per 1000 catheter-days in the SDUs was 4.1 in phase 1 and 1.6 in phase 2, P =0.005	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
16	Mehta et al	2013	VAP	N/R	N/R	N/R	The VAP rate was 17·43/1000 mechanical ventilator days during baseline, and 10·81 for intervention, showing a 38% VAP rate reduction (relative risk 0·62, 95% confidence interval 0·5–0·78, P=0·0001) NB: across whole intervention period = 84 months		N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
17	Murni et al	2015	The proportion of patients with an HAI, between the preintervention and postintervention periods.	N/R	Antibiotic use Hand hygiene compliance	Blood cultures: The BACTEC 9120 (BD Diagnostics, Sparks, Maryland, USA) was used for blood cultures. For each positive culture result, the type of isolated organism, number of positive culture sites, time to culture positivity, the presence of focal or generalized clinical signs of infection and an overall assessment of illness were recorded.	The risk of a patient developing a HAI decreased from 22.6% (95% CIs 20.3% to 24.9%) in the pre-intervention period to 8.6% (95% CI 7.3% to 10.2%) in the post-intervention period: RR 0.38 (95% CI 0.31 to 0.46) There was a reduction in the incidence density rate of HAI from 29.1 per 1000 patient days (360/12 358) to 9.3 (125/13 498) per 1000 patient days In-hospital mortality decreased from 10.4% (127/1227) to 8% (114/1419) (RR 0.78 (0.61 to 0.97))	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
18	Navoa et al	2013	CAUTI rates per 1000 UC-days	Mortality in the participating ICUs	Use of invasive devices (central line, mechanical ventilator, and UC), severity ill-ness score, underlying diseases, use of antibiotics, cultures taken, microorganism profile, bacterial resistance, length of stay. HH compliance	Urine culture and dipstick analysis for leukocyte esterase or nitrate and pyuria	The rate of CAUTI was 11.0 per 1000 UC-days at baseline and was decreased by 76% to 2.66 per 1000 UC-days during intervention [rate ratio [RR], 0.24; 95% confidence interval [CI], 0.11—0.53; P-value, 0.0001]	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
19	Ng Y.Y et al	2015	PICU-acquired bloodstream infection (BSI), which included clinical sepsis and laboratory-confirmed BSI, and CLABSIs per 1,000 CVC-days.	Mortality	N/R	Blood culture	The incidence rates of PICU-acquired BSIs were 88 per 1,000 admissions in baseline period and 41 per 1,000 admissions in end line period The incidence rates of catheter-related BSIs were 25.2 per 1,000 CVC-days in the baseline period and 9.3 per 1,000 CVC-days in the end line period. This translates to a 63% reduction in CLABSI during the intervention period ($p < 0.05$). PICU mortality baseline 9.1% (26/285), ENDLINE = 8.9% (39/436). P=0.9	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
20	Ogwang et al	2013	Prevalence of HCAI	N/R	N/R	No lab tests done	At baseline, 139 infections were detected in 115 of 410 surveyed patients, giving a prevalence of HAI of 34% and a prevalence of patients with HAI of 28%. At end line, 55 infections were detected in 45 of the 318 patients surveyed, giving a prevalence of HAI of 17% and a prevalence of patients with HAIs of 14% These data represent a 49.5% decrease in the prevalence of infected patients (P < 0.0001) and a 56% decline in the prevalence of HAI (P < 0.0001) compared with 2010 <u>Specific infections</u> Urinary tract- baseline = 28/410, end line = 23/318, p=0.83 Surgical wound, BL = 26/410, EL = 9/318, p = 0.02 Respiratory tract, BL = 33/410, EL =7/318, p=0.001 Bloodstream, BL=43/410, EL=14/318, p=0.002 Gastrointestinal, BL=9/410, EL=2/318, p=0.125	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
21	Rosenthal et al	2006	VAP rates	N/R	N/R	Blood culture - not all patients, some just diagnosed by physician	Rates of VAP were significantly lower in phase 2 than in phase 1 (51.28 vs 35.50 episodes of VAP per 1000 MV-days, respectively, RR = 0.69, 95% CI: 0.49-0.98, P = 0.003)	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
22	Rosenthal et al	2005	HCAIs	N/R	Hand hygeine compliance	Blood, urine cultures where necessary	Overall nosocomial infection in both ICUs decreased from 47.55 per 1000 patient-days (104/2187) to 27.93 per 1000 patient days (207/7409) (RR, 0.59; 95% CI: 0.46-0.74; P = .0001)	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
23	Rosenthal et al	2012	CLAB rates	Prevalence of microorganisms related to central line-associated bloodstream infection	Hand hygiene compliance	Blood cultures	The CLAB rate was 10.7 per 1,000 CL days in Phase 1, and in Phase 2, the CLAB rate decreased to 5.2 per 1,000 CL days (relative risk [RR] 0.48, 95% confidence interval [CI] 0.29–0.94, P = 0.02), showing a reduction of 52% in the CLAB rate.	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
24	Rosenthal et al	2012	CAUTI rates per 1000 UC-days	Prevalence of microorganisms	Hand hygiene compliance	Urine culture and dipstick analysis for leukocyte esterase or nitrate and pyuria	CAUTI rate was 7.86 per 1,000 UC-days, and in Phase 2, after intervention, the rate of CAUTI decreased to 4.95 per 1,000 UC-days [relative risk (RR) 0.63 (95 % confidence interval [CI] 0.55–0.72)], showing a 37 % rate reduction.	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
25	Von Dolinger de Brito et al	2007	HCAIs	N/R	Device utilization ratios for CVCs and ventilators	Cultures	The rate of HAI rose significantly from 12.8 to 18.6% (P < 0.01) after moving to the temporary unit, which had a lower sink:cot ratio and a higher monthly admission rate. In contrast, the rates of catheter associated staphylococcal bacteraemia decreased significantly after moving to the new NICU (P < 0.0001). Since peripherally inserted central catheters (PICCs) were introduced concomitantly with the move to the new unit, however, the catheter type may have contributed towards this reduction in CVC-related staphylococcal bacteraemias.	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
26	Zhou et al	2015	Central-line associated bloodstream infections (CLABSIs)	Microbiologic profiles	Central Line utilization ratio	Blood cultures were drawn peripherally for all cases. Standard laboratory methods were used to identify microorganisms, and standardized susceptibility testing was performed.	Overall CLABSI rate decreased gradually from 16.7 per 1,000 CL days in phase 1 (pre intervention) to 7.6 per 1,000 CL days in phase 2 (intervention) (P =0.08) to 5.2 per 1,000 CL days in phase 3 (post-intervention) (P < .01).	N/R	N/R	N/R

Study #	Author	Year	Primary outcome	Secondary outcomes	Additional outcomes	Laboratory-based measurement	Effect estimate	Process and implementation factors	Intervention uptake	Cost of intervention
27	Zhou et al	2013	VAP incidence	Mortality	Microbiologic features	Bacterial culture of Tracheobronchial samples	With implementation of the infection control program, there was a sustained decline in the VAP rates during the postintervention period (phase 2 (partial intervention) and phase 3 (full intervention)). There were 54 VAP events in the post-intervention period between 2008 and 2010; that is, a rate of 20.86 VAP/1,000 ventilator-days. When compared with the 48.84 VAP /1,000 ventilator-days in the preinterventional period (phase 1 - pre-intervention), the VAP rate was significantly lower (P = .01) Although VAP rate during phase 3 was further reduced from 25.73 in phase 2 to 18.50 VAP/1,000 ventilator-days, this reduction did not reach statistical significance (P = .15)	VAP rates in neonates decreased significantly when the NICU was moved from a crowded unit to a larger unit with 50% more staffing	N/R	N/R