

Sustained reduction of catheter associated bloodstream infections with enhancement of catheter bundle by chlorhexidine dressings over eleven years

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Online supplement Table 1: Intervention (Study periods)

Study Period	Time Period	Dressing Regimen
A (baseline)	January 2006 to October 2007	<p>Basic catheter bundle (for details see Supplemental Table 2).</p> <p>In summary:</p> <p>(1) General infection control measures (Hand Hygiene, standard and isolation precaution) and surveillance;</p> <p>(2) Guidelines for catheter insertion (checklist for material preparation, standardized hair cut with clipper and CHG bases skin disinfection, maximal sterile barrier precaution);</p> <p>(3) Handling: avoidance of needle and needless connectors, systematic CHG disinfection of stop-cock with new cups at each opening of the hub);</p> <p>(4) Maintenance: Daily check for catheter necessity, signs of catheters infections and dressing integrity and need for replacement;</p> <p>(5) Surveillance and Feedback: to guarantee uniform application of the bundle, a designated physician and a designated nurse led the whole bundle and gave periodic feedback based on surveillance data. Sterile gauze, covered by Mefix® Dressing (No CHG-dressings)</p>
B	November 2007 to November 2009	CHG-sponge on jugular and femoral CVC (all units)
C	December 2009 to May 2011	CHG-sponge on all CVC and arterial catheters (all units)
D	June 2011 to May 2013	<p>CHG-sponge in 3 units (18 beds) and</p> <p>CHG-gel on 2 units (14 beds)</p> <p>on all CVC and arterial catheters</p>
E	June 2013 to December 2014	<p>CHG-gel in all units</p> <p>on all CVC and arterial catheters</p>

Online supplement Table 2: Catheter bundle ^{1,2,3}

	Specific components
General infection control measures	
Hand hygiene, standard and isolation precautions	<ul style="list-style-type: none"> - Systematic hand hygiene with an alcoholic hand-rub solution - Hands washing with soap and water for soiled hands systematically followed by hand disinfection with an alcoholic hand-rub solution - Standard precautions including detailed guidelines for the use of hospital clothes, gloves, gowns, protective glasses - Additional isolation precaution: contact, droplet, airborne when indicated
Surveillance of infections	<ul style="list-style-type: none"> - Quarterly review of all positive blood cultures. First, each episode was attributed to the following settings: (1) community-acquired (<48h of hospital admission); (2) hospital non-ICU acquired (<48h of ICU admission) and (3) ICU-acquired. Second, ICU-acquired positive blood cultures were further adjudicated to 4 categories: (1) catheter-related bloodstream infection; (2) primary bacteremia; (3) secondary bacteremia, and (4) contamination adjudication to the following categories of stream infections according to standard definitions (Supplemental Figure 1) by one or two ICU attending physician and 1 dedicated infection control nurses. - Bi-annual feedback to the all the staff of the ICU (nurses-assistant, nurses, physician)
Guidelines for catheter insertion	
Checklist for material preparation	By the assistant of the operator to avoid interruptions during the insertion
Recommendation for placing patient and devices	Positioning of the patient and preparation of the material required for insertion, including US machine by the operator and the

	assistant according to the site chosen for the insertion which is left to the choice of the physician in charge
Skin preparation	Hair removal: with a disposable clipper, shaving forbidden Two-level kit insertion 1 of 2: Skin disinfection with a colored solution (Chlorhexidine 2% with alcohol 70%, systematic since 2011) by the operator using a cap, a surgical mask and sterile gloves
Maximal sterile barrier precaution	Two-level insertion kit 1 of 2: Operator remove gloves, hand hygiene and cloth with a sterile gown and new sterile gloves. Large sterile draping surrounding the insertion area
Recommendation for catheter insertion under US guidance	Specific training of all operators for the insertion under US guidance (systematic since 2012)
Recommendation for catheter fixation	Suture of the catheter at its emergence at the insertion site. Sutures to be covered by the CHG-sponge or CHG-gel dressings (See Supplemental Figure 4)
Recommendation for catheter dressing	Progressive introduction of chlorhexidine dressings according to the timing specified in Table 1. Theoretical education and bedside training was provided to all HCW working in the ICU over all the study period.
Recommendation for documentation	Time and date of insertion (site and type of catheter) and dressing prospectively recorded in the computerized information system as a continuous process.
Guidelines for catheter handling and maintenance	
Checklist for maintenance	Specific catheter maintenance checklist during the daily medical and nursing rounds: catheter needed, standardization for administration set change, dressing change

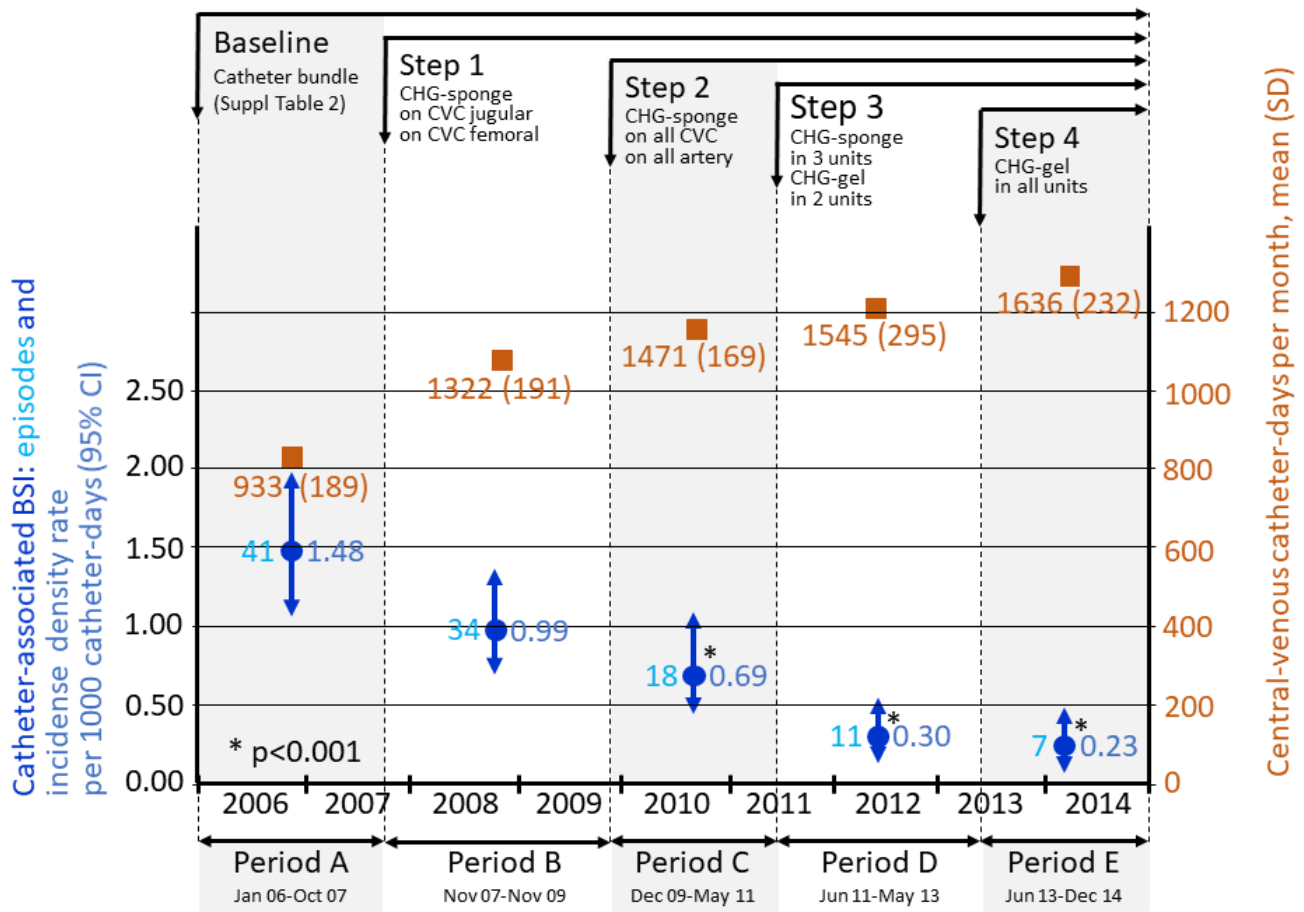
Catheter handling	<p>Opening of the hub: on antiseptic-impregnated pads (chlorhexidine 2% and alcohol 70%) after hand disinfection.</p> <p>New caps without disinfection coating at each opening</p> <p>Lines changed every 96h, every 24h for lipids and blood products</p>
Dressing change	<p>Systematic new CHG-dressing of all CVC and arterial catheter upon ICU admission with catheter already inserted.</p> <p>In the absence of indication for change (unstuck, leaking, bloody, humidity saturated), chlorhexidine dressings are used up to 7 consecutive days</p>
Check for catheter infection	<p>During the daily medical and nursing round:</p> <p>Blood cultures performed in case of clinical sign of infection (sepsis)</p> <p>Inspection and palpation of all catheter insertion site</p>
Recommendation for catheter change or replacement	<p>Guidewire exchange of CVC and arterial lines with culture for any clinical suspicion of infection in the absence of other clinical sign of infection</p> <p>Catheter removal and culture if clinical suspicion of an infection at the insertion site</p> <p>Peripheral catheter systematically changes at ICU admission and every 48 to 72h</p>

1. All measures and detailed comments available as print document and on the website of the ICU with all other type of recommendations and policies used in the ICU.
2. Systematic training of all newly introduced HCW (physician, nurses and assistant nurses of any qualification and experience)
3. Dedicated clinical nurses in charge of instruction of HCW and regular bedside teaching to ensure the maintenance of all techniques of care detailed above
4. All measures are listed and detailed in the procedure of nursing and medical care (illustrated technical sheets available in dedicated binders and in the intranet of the ICU, part of the procedures certified by an ISO 9001 accreditation).

Online supplement Table 3: Blood cultures performed over the study and post study periods

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Contaminated BC	66	83	70	90	90	51	62	60	52	50	74	54	47
Contaminated BC/100BC	1.2	1.2	1	1.4	1.5	0.85	1.06	0.8	0.7	0.6	0.76	0.65	0.64
BC total	5500	6917	7000	6429	6000	6000	5849	7500	7429	8333	9737	8308	7321
BC/100 pat-days	58.4	68.8	76.2	66.0	62.1	56.9	54.8	66.9	65.5	70.3	83.1	72.5	71.4

Online supplement Figure 1: Catheter use, episodes and incidence density rate of CABSBI by period

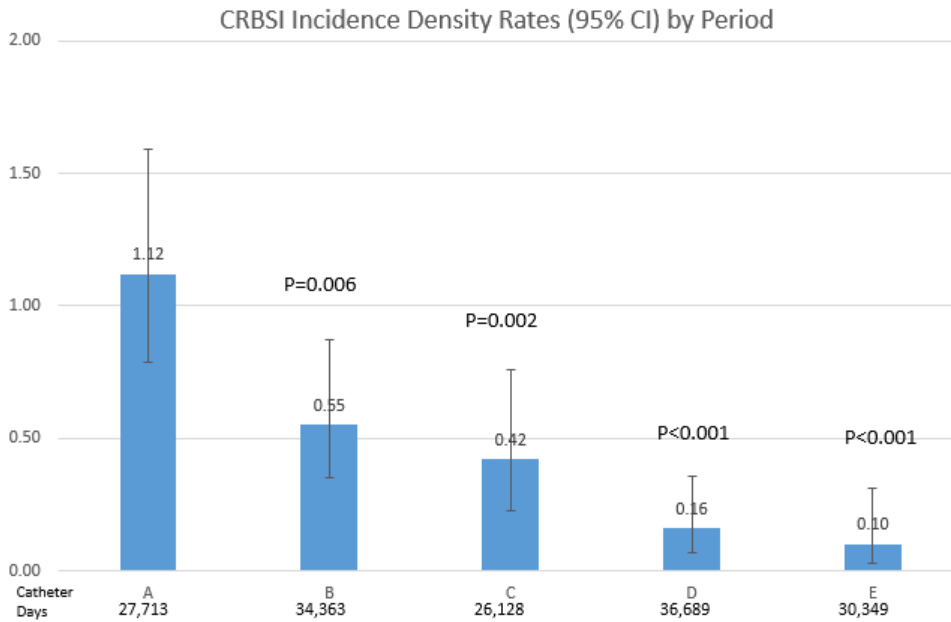


Legend to Online supplement Figure 1: p values from comparison to period A were 0.085 for period B, 0.0007 for period C, < 0.001 for period D and E. BSI denotes bloodstream infection, i.e CRBSI + primary bacteremia.

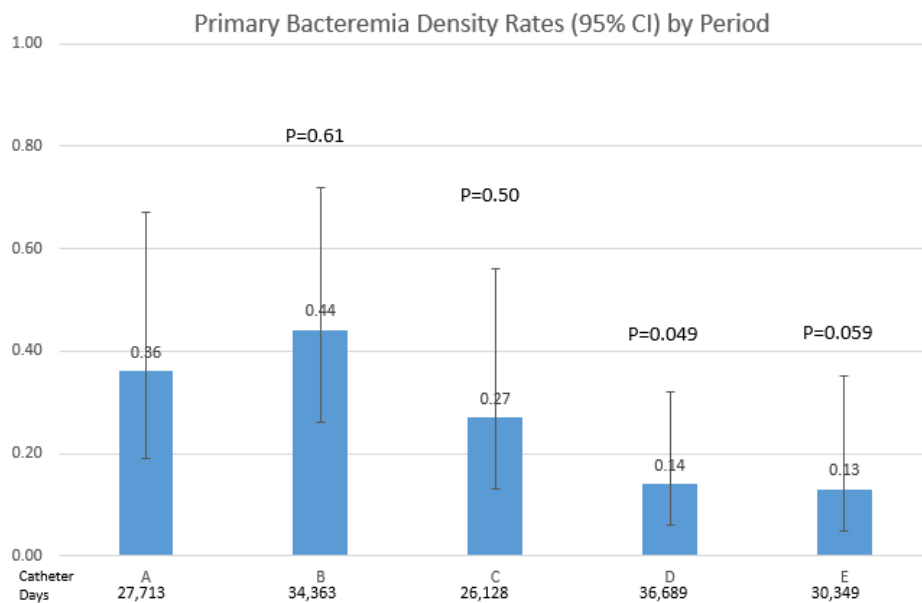
Among 70 CRBSI, the type and site of insertion of the catheter were: CVC jugular: 47 (65.7%), CVC subclavian 13 (18.6%), CVC femoral 10 (14.3%) and arterial radial 1 (1.4%)

Online supplement Figure 2: Incidence density rates (with 95% CI) by Period for each type of infection; p values are from the comparison to Period A. **a)** CRBSI (Catheter Related Blood Stream Infection), **b)** Primary bacteremia

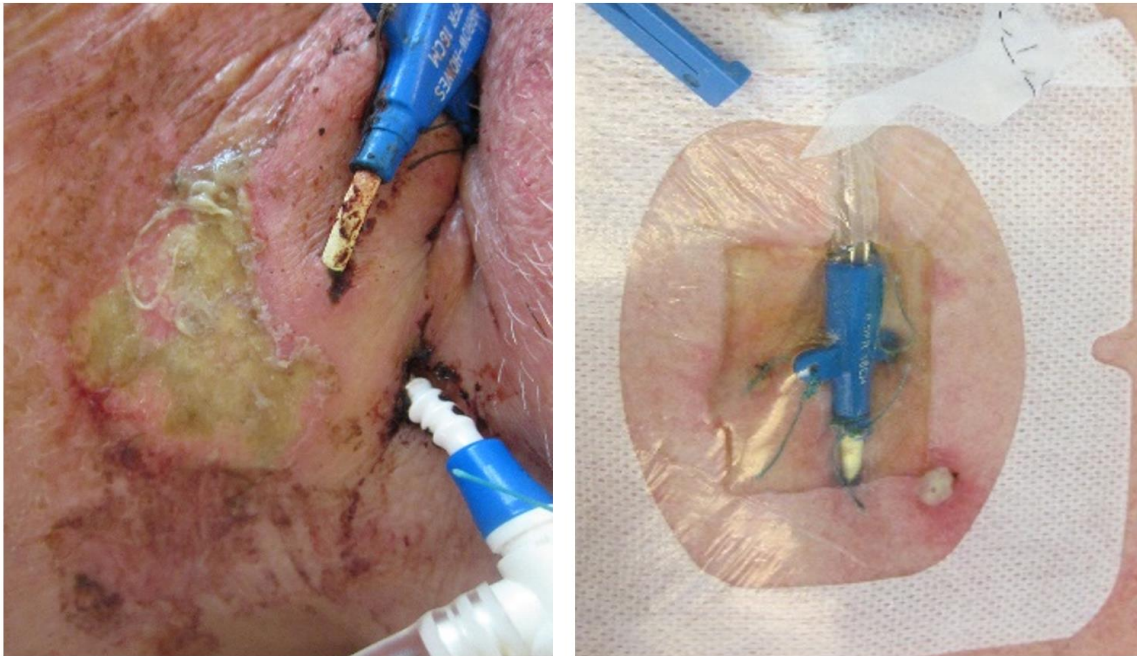
Online supplement Figure 2a



Online supplement Figure 2b



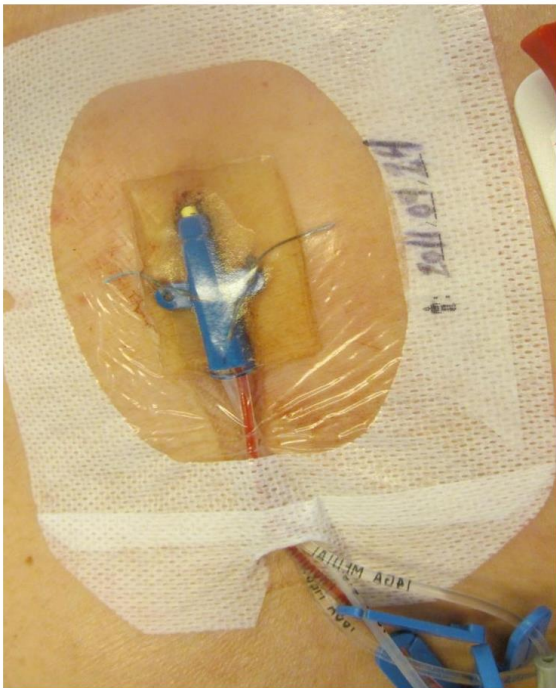
Supplemental Figure 3: Examples of skin reactions observed with CHG-gel dressing



Supplemental Figure 4: CHG-gel dressing covering insertion and suture sites

a) on central venous catheter

b) on arterial catheter.



Legend to Suppl Fig 4: CHG-gel which covers the insertion site and the sutures of the catheters