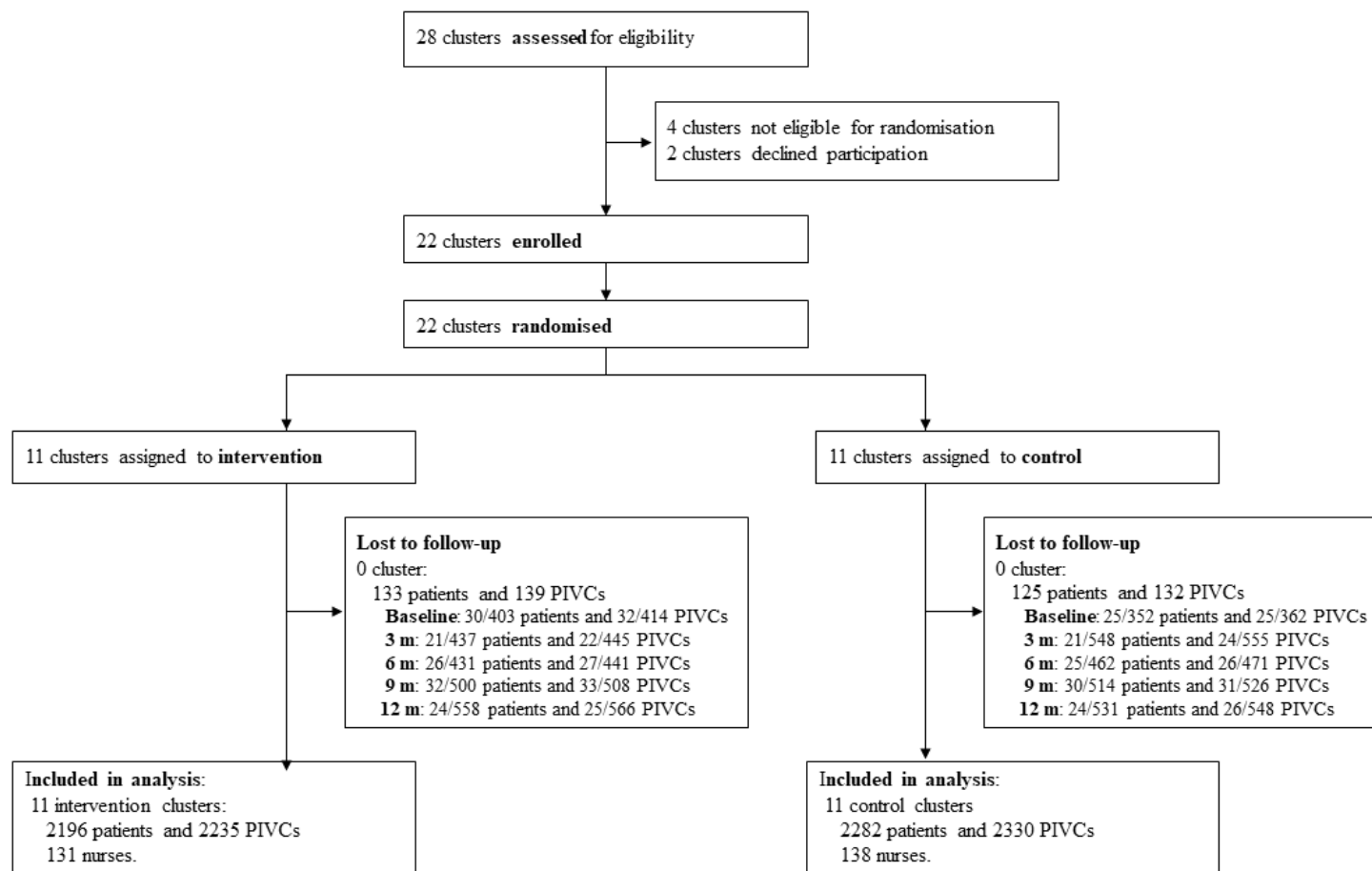


Flow diagram of trial profile.



PIVC: Peripheral intravenous catheter; m: months

Baseline characteristics of hospital wards.

Baseline characteristics of hospital wards	Intervention (n = 11)	Control (n = 11)	Mean difference (95% CI)
	Mean (SD)	Mean (SD)	
Total patient admissions	33.91 (17.29)	29.72 (10.73)	4.18 (-8.62 to 16.98)
Patient age (years)	69.56 (4.29)	69.92 (5.38)	-0.36 (-4.68 to 3.97)
% Patient gender female	39.1 (12.11)	41.03 (9.63)	-1.93 (-11.67 to 7.80)
% Patient gender male	60.9 (12.11)	58.97 (9.63)	1.93 (-7.80 to 11.67)
% Comorbidity	93.58 (6.37)	92.75 (4.75)	0.83 (-4.17 to 5.82)
% Cognitive impairment	14.46 (9.23)	32.21 (18.01)	-17.75 (-30.48 to 5.02)
% Use of antibiotics	37.41 (12.84)	34.62 (15.97)	2.80 (-10.09 to 15.69)
Total nurses	11.91 (1.92)	12.55 (1.69)	-0.64 (-2.25 to 0.97)
% Nurses gender female	84.42 (11.58)	83.45 (17.58)	0.97 (-12.27 to 14.21)
Nurse age (years)	39.8 (4.72)	40.07 (4.27)	-0.28 (-4.28 to 3.73)
Years employed as nurse	16.22 (5.04)	16.56 (4.66)	-0.33 (-4.65 to 3.99)
Primary outcome modified intention-to-treat analysis			
% PIVC failure	45.30 (1.97)	44.85 (3.02)	0.45 (-1.81 to 2.72)
Primary outcome per protocol-prespecified			
% PIVC failure	40.28 (4.23)	41.09 (4.54)	-0.80 (-4.70 to 3.10)
Secondary outcomes			
Total PIVCs	34.73 (17.89)	30.64 (11.13)	4.09 (-9.16 to 17.34)
PIVC length of time (days)	3.55 (0.45)	3.68 (0.45)	-0.13 (-0.54 to 0.27)
% Phlebitis	13.43 (4.37)	14.11 (3.39)	-0.68 (-4.16 to 2.80)
% Extravasation	19.62 (3.54)	20.70 (2.89)	-1.08 (-3.96 to 1.80)

% Obstruction	7.23 (3.02)	5.91 (3.53)	1.32 (-1.60 to 4.24)
% Dislodgement	5.02 (4.36)	3.76 (3.15)	1.25 (-2.13 to 4.63)
% CRBSI	0.65 (1.28)	0	0.65 (-0.16 to 1.45)
% 2 or more PIVCs in situ per patient	1.94 (3.24)	2.65 (3.39)	-0.71 (-3.66 to 2.24)
% Unnecessary PIVC	10.48 (9.25)	8.96 (8.85)	1.52 (-6.54 to 9.57)
Adherence to clinical practice guideline recommendations			
% Recommendations completed	63.86 (12.57)	57.71 (11.00)	6.14 (-4.43 to 16.57)
% Patient knowledge related to PIVC	57.35 (23.30)	45.28 (16.50)	12.08 (-5.88 to 30.03)
% PIVC adequacy and Insertion	54.66 (12.03)	54.91 (15.01)	-0.24 (-12.34 to 11.86)
% PIVC inserted in forearm	42.69 (13.21)	38.68 (13.38)	4.02 (-7.81 to 15.84)
% PIVC inserted with 20-22 gauge	82.08 (18.82)	81.53 (12.36)	0.55 (-13.61 to 14.71)
% Visual inspection of insertion site	49.39 (30.77)	38.77 (17.80)	10.62 (-11.74 to 32.98)
% Dressing type	92.22 (19.04)	86.12 (23.97)	6.10 (-13.15 to 25.35)
% Dressing status	57.17 (23.67)	45.56 (18.34)	11.61 (-7.22 to 30.44)
% Management of PIVC flushing	79.46 (12.02)	82.70 (8.95)	-3.24 (-12.67 to 6.18)
% Record of PIVC care	56.75 (40.81)	50.95 (42.03)	5.80 (-31.05 to 42.64)
% PIVCs with all recommendations completed	7.18 (10.12)	3.90 (5.92)	3.28 (-4.10 to 10.65)

Environment Evidence-based clinical practice			
PIVC care questionnaire (PIVCareQ)			
General asepsis and cutaneous antisepsis	3.31 (0.23)	3.23 (0.14)	0.08 (-0.09 to 0.25)
Insertion of PIVC	3.13 (0.17)	3.04 (0.12)	0.09 (-0.04 to 0.21)
Care of PIVC	3.08 (0.10)	3.00 (0.19)	0.08 (-0.06 to 0.22)
General principles of PIVC management	3.22 (0.11)	3.16 (0.12)	0.06 (-0.04 to 0.16)
Strategies of PIVC removal	3.35 (0.14)	3.23 (0.16)	0.12 (-0.01 to 0.25)
Record of PIVC	3.21 (0.18)	3.21 (0.22)	0.00 (-0.19 to 0.18)
Patient education	2.92 (0.19)	2.88 (0.35)	0.04 (-0.21 to 0.29)
Professional education	2.28 (0.40)	2.20 (0.49)	0.08 (-0.32 to 0.48)
EBCP Individual (EBPQ)			
Use/Practice	4.19 (0.51)	4.33 (0.43)	-0.14 (-0.56 to 0.28)
Attitudes	5.10 (0.30)	5.07 (0.29)	0.03 (-0.24 to 0.29)
Knowledge/Competence	4.32 (0.33)	4.47 (0.36)	-0.15 (-0.46 to 0.15)
EBCP Context (PES-NWI)			
Nurses' participation	2.32 (0.33)	2.19 (0.30)	0.13 (-0.14 to 0.41)
Quality of nursing care	2.86 (0.46)	2.77 (0.56)	0.09 (-0.36 to 0.55)
Support of Nurse Manager	3.26 (0.39)	3.21 (0.36)	0.05 (-0.29 to 0.38)
Staff and resources adequacy	2.04 (0.35)	2.01 (0.45)	0.03 (-0.33 to 0.39)
Nurse/Physician relation	2.51 (0.44)	2.42 (0.41)	0.09 (-0.29 to 0.47)
Baseline characteristics of hospital wards			

Effect and process outcomes of trial at 12 months.

Characteristics of hospital wards to 12 months	Intervention (n = 11)	Control (n=11)	Mean difference (95% CI)	p value
	Mean (SD)	Mean (SD)		
Total patient admissions	48.55 (25.79)	46.09 (16.16)	2.45 (-16.69 to 21.60)	0.792
Patient age (years)	67.79 (4.22)	69.71 (5.86)	-1.92 (-6.46 to 2.62)	0.389
% Patient gender female	51.07 (12.04)	43.37 (13.08)	7.70 (-3.48 to 18.88)	0.166
% Patient gender male	48.93 (12.04)	56.63 (13.08)	-7.70 (-18.88 to 3.48)	0.166
% Comorbidity	90.88 (6.49)	90.93 (9.22)	-0.05 (-7.14 to 7.04)	0.989
% Cognitive impairment	22.08 (10.06)	32.19 (18.89)	-10.11 (-23.57 to 3.35)	0.133
% Use of antibiotics	35.74 (16.69)	37.24 (14.22)	-1.50 (-15.29 to 12.29)	0.823
Total nurses	12.09 (2.07)	12.27 (2.28)	-0.18 (-2.12 to 1.76)	0.847
% Nurses gender female	84.29 (10.92)	81.82 (18.10)	2.47 (-10.82 to 15.76)	0.702
Nurse age (years)	39.80 (4.72)	40.07 (4.27)	-0.28 (-4.28 to 3.73)	0.887
Years employed as nurse	16.22 (5.04)	16.56 (4.66)	-0.33 (-4.65 to 3.99)	0.874
Primary outcome modified intention-to-treat analysis				
% PIVC failure	37.10 (1.32)	46.49 (2.59)	-9.39 (-11.22 to -7.57)	< 0.001
Relative risk (95% CI)	HR 0.87 (0.82 to 0.93)	HR 1.14 (1.07 to 1.20)	-	-
Primary outcome per protocol-prespecified				
% PIVC failure	33.47 (2.98)	41.06 (4.62)	-7.59 (-11.05 to -4.13)	<0.001
Relative risk (95% CI)	HR 0.893 (0.84 to 0.95)	HR 1.112 (1.05 to 1.18)	-	-
Secondary outcomes				
Total PIVCs	49.18 (26.13)	47.45 (17.85)	1.73 (-18.17 to 21.63)	0.858
PIVC length of time (days)	3.19 (0.51)	3.66 (0.25)	-0.47 (-0.83 to 0.11)	0.012
% Phlebitis	13.08 (3.54)	16.66 (3.95)	-3.57 (-6.91 to -0.24)	0.037

% Extravasation	15.93 (2.84)	18.73 (3.28)	-2.80 (-5.53 to -0.07)	0.045
% Obstruction	4.46 (2.45)	5.67 (1.22)	-1.21 (-2.93 to 0.51)	0.157
% Dislodgement	3.63 (3.11)	5.43 (2.84)	-1.81 (-4.45 to 0.84)	0.170
% CRBSI	0	0.12 (0.40)	-0.12 (-0.37 to 0.13)	0.329
% 2 or more PIVCs in situ per patient	1.11 (1.78)	2.00 (4.00)	-0.89 (-3.65 to 1.86)	0.508
% Unnecessary PIVC	9.05 (11.38)	11.04 (5.86)	-1.99 (-10.04 to 6.06)	0.612
Multimodal intervention content and dosage				
Poster with recommendations	5	n/a	n/a	n/a
Video protocols	3	n/a	n/a	
E-learning (completed courses)	33	n/a	n/a	
Website (visits)	n/a	n/a	n/a	
Face-to-face training	No	n/a	n/a	
Feedback of results	16 hours	n/a	n/a	
N° of Internal facilitators	5.36 (0.67)	n/a	n/a	
Adherence to clinical practice guidelines recommendations				
% Recommendations completed	73.14 (8.71)	60.29 (8.29)	12.57 (5.14 to 20.14)	0.002
% Patient knowledge related to PIVC	63.32 (15.32)	48.21 (19.74)	15.11 (-0.61 to 30.82)	0.059
% PIVC adequacy and insertion	53.96 (14.70)	54.67 (19.83)	-0.71 (-16.24 to 14.81)	0.925
% PIVC inserted in forearm	45.09 (10.86)	37.14 (15.01)	7.95 (-3.70 to 19.60)	0.170

% PIVC inserted with 20-22 gauge	82.26 (15.96)	81.51 (14.38)	0.75 (-12.77 to 14.27)	0.909
% Visual inspection of insertion site	72.85 (20.67)	49.11 (21.49)	23.74 (4.99 to 42.50)	0.016
% Dressing type	97.00 (5.07)	90.31 (18.92)	6.69 (-5.63 to 19.01)	0.271
% Dressing status	66.86 (17.10)	51.37 (25.26)	15.49 (-3.69 to 34.68)	0.108
% Management of PIVC flushing	79.47 (12.81)	74.79 (14.33)	4.69 (-7.40 to 16.78)	0.428
% Record of PIVC care	76.82 (29.23)	53.67 (39.00)	23.14 (-7.51 to 53.80)	0.131
% PIVCs with all recommendations completed	13.59 (11.54)	4.08 (4.76)	9.51 (1.66 to 17.36)	0.020
PIVC care questionnaire (PIVCareQ)				
General asepsis and cutaneous antisepsis	3.57 (0.22)	3.19 (0.25)	0.38 (0.17 to 0.59)	0.001
Insertion of PIVC	3.49 (0.15)	3.03 (0.19)	0.46 (0.31 to 0.61)	< 0.001
Care of PIVC	3.39 (0.19)	3.05 (0.19)	0.34 (0.17 to 0.51)	< 0.001
General principles of PIVC management	3.54 (0.07)	3.19 (0.18)	0.34 (0.22 to 0.47)	< 0.001
Strategies of PIVC removal	3.54 (0.17)	3.20 (0.17)	0.34 (0.19 to 0.49)	< 0.001
Record of PIVC	3.50 (0.18)	3.16 (0.24)	0.35 (0.16 to 0.53)	0.001
Patient education	3.10 (0.16)	2.88 (0.10)	0.21 (0.09 to 0.34)	0.002
Professional education	2.88 (0.35)	2.49 (0.43)	0.40 (0.05 to 0.75)	0.028
Effect and process outcomes of intervention and control group at 12 months				

Economic evaluation of resources required at 12 months.

Economic evaluation	Mean (SD), €		Mean difference (95% CI)	p value
	Intervention (n = 2235)	Control (n=2330)		
Cost of staff time for PIVC insertion ^{a, b}	3.00	3.00	-	-
Costs associated with PIVC first insertion and replacement	7.31 (2.59)	7.62 (2.61)	-0.31 (-0.46 to -0.16)	< 0.001
Initial PIVC, dressing, add-on devices, and staff time ^{a, b}	5.22 (0.23)	5.21 (0.21)	0.01 (0.00 to 0.03)	0.015
PIVC replacement, dressing, add-on devices, and staff time	2.09 (2.56)	2.41(2.60)	-0.32 (-0.47 to -0.17)	< 0.001
Costs associated with treatment of complications	9.35 (190.88)	33.27 (389.29)	-23.91 (-41.82 to -6.01)	0.009
Treatment of PIVC-related primary bloodstream infections	4.24 (147.85)	21.00 (342.19)	-16.76 (-32.17 to -1.35)	0.033
Treatment of PIVC non-infectious complications	5.12 (120.91)	12.27 (187.00)	-7.16 (-16.33 to 2.03)	0.126
Total costs associated with insertion and removal PIVC	16.67 (191.05)	40.89 (389.55)	-24.22 (-42.14 to -6.30)	0.008
Costs of facilitation ^{a, c}	4.72	-	-	-
Total costs	21.39 (191.05)	40.89 (389.55)	-19.50 (-37.20 to -1.80)	0.033
Economic evaluation of resources required during the clinical trial				

€ euro; ^a SDs not available because costs were calculated based on weighted mean times; ^b Mean calculated based on weighted average times during catheter insertion (9 minutes per catheter inserted); ^c Mean calculated based on weighted average times (each hospital ward in intervention group employed 48 hours for the trial; 1 hour = €20).

Evolution of effect and process outcomes at 3, 6 and 9 months.

Characteristics of hospital wards	3 months			6 months			9 months		
	Intervention (n = 11) Mean (SD)	Control (n = 11) Mean (SD)	p-value	Intervention (n = 11) Mean (SD)	Control (n = 11) Mean (SD)	p-value	Intervention (n = 11) Mean (SD)	Control (n = 11) Mean (SD)	p-value
Total patient admissions	37.82 (14.02)	47.91 (18.05)	0.159	36.82 (15.04)	39.73 (18.68)	0.692	42.55 (13.78)	44.00 (15.81)	0.820
Patient age, years, median (IQR)	69 (66 - 70)	68 (64 - 75)	0.548	66 (64 - 72)	68 (63 - 73)	0.716	68 (67 - 73)	67 (66 - 73)	0.722
% Patient gender female	47.68 (11.87)	44.88 (12.95)	0.602	44.64 (12.04)	44.58 (13.24)	0.576	43.86 (10.70)	46.53 (14.58)	0.630
% Patient gender male	52.32 (11.87)	55.12 (12.95)	0.602	52.36 (12.04)	55.42 (13.24)	0.576	56.14 (10.70)	53.47 (14.58)	0.630
% Comorbidity	91.64 (5.29)	92.93 (5.58)	0.585	93.12 (6.70)	90.36 (9.78)	0.449	94.22 (5.35)	90.89 (6.54)	0.205
% Cognitive impairment	20.66 (10.70)	23.17 (14.15)	0.643	22.31 (15.39)	34.51 (19.22)	0.116	26.59 (14.87)	32.35 (17.47)	0.415
% Use of antibiotics	37.51 (10.72)	44.85 (13.44)	0.172	33.71 (13.99)	39.32 (13.47)	0.349	37.71 (16.18)	37.95 (14.47)	0.972
Primary outcome modified intention-to-treat analysis									
% PIVC failure	42.58 (2.71)	46.63 (4.19)	0.014	39.03 (3.30)	48.30 (5.36)	<0.001	39.60 (2.37)	45.89 (3.23)	<0.001
Primary outcome per protocol-prespecified									
% PIVC failure	37.79 (2.83)	39.99 (6.00)	0.284	34.45 (1.89)	42.98 (6.53)	<0.001	35.14 (3.34)	40.41 (5.09)	0.009
PIVC outcomes									
Total PIVCs	38.45 (14.19)	48.27 (18.42)	0.177	37.64 (15.39)	40.45 (19.01)	0.706	43.18 (14.12)	45.00 (16.61)	0.785
PIVC dwell time (hours), median (IQR)	80 (50 - 115)	95 (65 - 115)	0.254	75 (45 - 105)	90 (60 - 115)	0.203	75 (45 - 110)	85 (55 - 115)	0.189
% Phlebitis	12.66 (2.72)	18.53 (8.25)	0.037	11.99 (2.95)	18.13 (6.50)	0.010	15.00 (5.03)	15.39 (2.66)	0.825
% Extravasation	18.91 (2.83)	16.82 (3.23)	0.122	16.77 (2.03)	18.56 (2.79)	0.100	16.26 (2.53)	20.31 (3.66)	0.007
% Obstruction	6.21 (1.99)	4.64 (2.25)	0.099	5.69 (1.62)	6.32 (0.79)	0.261	3.88 (2.13)	4.72 (1.49)	0.296
% Dislodgement	4.79 (3.61)	6.64 (2.86)	0.199	4.58 (2.23)	5.32 (2.13)	0.438	4.46 (3.23)	5.48 (3.33)	0.474
% CRBSI	0.45 (1.00)	0.64 (1.17)	0.679	0	0.43 (1.03)	0.184	0	0.37 (0.83)	0.152
% 2 or more PIVCs in situ per patient	1.53 (2.17)	0.58 (1.02)	0.202	1.87 (3.34)	1.72 (2.80)	0.911	1.27 (1.98)	1.91 (2.95)	0.555
% Unnecessary PIVC	11.35 (14.60)	11.95 (7.53)	0.904	6.91 (10.95)	11.18 (9.67)	0.345	5.78 (6.52)	11.32 (6.65)	0.062

Multimodal intervention									
Poster with recommendations	4	n/a		5	n/a		5	n/a	
Video protocols	3	n/a		3	n/a		3	n/a	
E-learning (completed courses)	153	n/a		21	n/a		15	n/a	
Website (visits)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Face-to-face training (1 per nurse)	50 hours	n/a		no	n/a		no	n/a	
Feedback of results (1 per quarter)	9 hours	n/a		9 hours	n/a		14 hours	n/a	
Number of Internal facilitators	3 (0)	n/a		3 (0)	n/a		4-64 (1-03)	n/a	
Adherence to clinical practice guideline recommendations									
% Recommendations completed	64.00 (10.00)	59.43 (9.43)	0.287	72.00 (7.43)	58.00 (8.29)	< 0.001	70.00 (9.86)	58.71 (6.43)	0.005
% Patient knowledges related to PIVC	56.75 (21.75)	54.23 (19.71)	0.778	66.72 (16.56)	49.35 (18.93)	0.033	62.22 (20.09)	50.94 (16.84)	0.169
% PIVC adequacy and insertion	55.33 (16.52)	46.74 (19.69)	0.281	52.41 (12.27)	52.84 (14.86)	0.942	53.58 (11.92)	49.68 (12.58)	0.464
% Visual inspection of insertion site	57.78 (25.94)	43.65 (18.27)	0.155	71.29 (14.20)	45.94 (19.62)	0.002	64.94 (23.12)	42.24 (20.49)	0.024
% Dressing type	88.20 (17.72)	91.85 (15.95)	0.617	93.97 (10.77)	84.86 (26.07)	0.297	94.02 (12.16)	89.61 (18.64)	0.519
% Dressing status	53.77 (23.71)	47.15 (19.54)	0.484	66.37 (16.17)	44.18 (15.13)	0.003	60.34 (18.48)	45.96 (17.21)	0.073
% Management of PIVC flushing	72.87 (15.15)	80.78 (11.34)	0.181	76.48 (14.94)	77.23 (12.57)	0.901	78.36 (12.07)	79.19 (13.23)	0.879
% Record of PIVC care	63.00 (36.68)	51.49 (41.78)	0.500	76.56 (25.05)	51.35 (40.34)	0.093	76.44 (27.70)	53.78 (38.66)	0.130
% PIVCs with all recommendations completed	7.55 (7.43)	4.94 (4.65)	0.336	12.99 (7.64)	3.64 (3.15)	0.001	10.93 (9.47)	2.94 (3.27)	0.016
Evolution of effect and process outcomes at 3, 6 and 9 months.									

Evolution of type, hospital length of time and adverse events associated with CRBSI at baseline, 3, 6, 9 and 12 months.

Outcomes	Baseline		3 months			6 months			9 months			12 months		
	Interv (n=11) Mean (SD)	Control (n=11) Mean (SD)	Interv (n=11) Mean (SD)	Control (n=11) Mean (SD)	p- value	Interv (n=11) Mean (SD)	Control (n=11) Mean (SD)	p- value	Interv (n=11) Mean (SD)	Control (n=11) Mean (SD)	p- value	Interv (n=11) Mean (SD)	Control (n=11) Mean (SD)	p- value
% CRBSI	0.65	0	0.45 (1.00)	0.64 (1.17)	0.679	0	0.43 (1.03)	0.184	0	0.37 (0.83)	0.152	0	0.12	0.329
% CRBSI type 1	0.43	0	0.45 (1.00)	0	0.156	0	0.15 (0.49)	0.184	0	0	NA	0	0	NA
% CRBSI type 2	0	0	0	0.14 (0.47)	0.329	0	0.28 (0.62)	0.184	0	0	NA	0	0	NA
% CRBSI type 3	0.22	0	0	0.50 (1.14)	0.162	0	0	n/a	0	0.37 (0.83)	0.152	0	0.12	0.329
Hospital length of time associated with CRBSI	4.00 (7.47)	0	2.27 (5.06)	8.00 (16.85)	0.244	0	2.91 (6.61)	0.160	0	4.36 (9.80)	1.55	0	2.00 (6.63)	0.329
% Serious adverse events associated with CRBSI	0	0	0	0.50 (1.14)	0.162	0	0	NA	0	0.37 (0.83)	0.152	0	0	NA
% Intensive care unit admissions	0	0	0	0.50 (1.14)	0.162	0	0	NA	0	0.37 (0.83)	0.152	0	0	NA
% Death	0	0	0	0	NA	0	0	NA	0	0	NA	0	0	NA
Evolution of type, hospital length of time and adverse events associated with CRBSI at baseline, 3, 6, 9 and 12 months.														