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Stepwise introduction of the 'Best Care Always' central-line-associated bloodstream infection prevention bundle in a network of South African hospitals

G.A. Richards [a,*], A.J. Brink [b,c], A.P. Messina [d], C. Feldman [a], K. Swart [d], D. van den Bergh [d] for the Netcare Antimicrobial Stewardship and Infection Prevention Study Alliance

[a] *Charlotte Maxeke Johannesburg Academic Hospital and Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa*
[b] *Ampath National Laboratory Services, Milpark Hospital, Johannesburg, South Africa*
[c] *Division of Infectious Diseases and HIV Medicine, Department of Medicine, University of Cape Town, Cape Town, South Africa*
[d] *Department of Quality Systems and Innovation, Netcare Hospitals Ltd, Johannesburg, South Africa*

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SUMMARY

Background: Healthcare-associated infection (HCAI) remains a major international problem.

Aim: The 'Best Care Always!' (BCA) campaign was launched in South Africa to reduce preventable HCAI, including central-line-associated bloodstream infection (CLABSI).

Methods: The intervention took place in 43 Netcare Private Hospitals, increasing later to 49 with 958 intensive care units (ICUs) and 439 high-care (HC) beds and 1207 ICUs and 493 HC beds, respectively. Phase 1, April 2010 to March 2011, ICU infection prevention and control (IPC) nurse-driven change: commitment from management and doctors and training of IPC nurses. Bundle compliance and infections per 1000 central-line-days were incorporated as standard IPC measures and captured monthly. Phase 2, April 2011 to March 2012, breakthrough collaborative method: multiple regional learning sessions for nursing leaders, IPC nurses and unit managers. Phase 3, April 2012 to May 2016: sustained goal-setting, benchmarks, ongoing audits.

Findings: A total of 1,119,558 central-line-days were recorded. Bundle compliance improved significantly from a mean of 73.1% [standard deviation (SD): 11.2; range: 40.6–81.7%] in Phase 1 to a mean of 90.5% (SD: 4.7; range: 76.5–97.2%) in Phase 3 ($P = 0.0004$).

The CLABSI rate declined significantly from a mean of 3.55 (SD: 0.82; range: 2.54–5.78) per 1000 central-line-days in Phase 1 to a mean of 0.13 (SD: 0.09; range: 0–0.33) ($P < 0.0001$).

* Corresponding author. Address: c/o Dept of Medicine Medical School, 7 York Rd, Parktown, 2193 Johannesburg, South Africa. Tel.: +27 114883614; fax: +27 114884675.
E-mail address: guy.richards@wits.ac.za (G.A. Richards).

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Conclusion: This intervention, the first of its kind in South Africa, through considerable motivation and education, and through competition between hospitals resulted in significant decreases in CLABSI.

Introduction

Infection prevention has been identified as a priority by the South African National Department of Health, particularly in the intensive care unit (ICU) where healthcare-associated infections (HCAIs) in developing countries are up to triple that of the USA [1]. One of the most prevalent are central-line-associated bloodstream infections (CLABSI) which are an avoidable complication of venous access, to the extent that in the USA these infections are no longer reimbursed by the Centers for Medicare and Medicaid Services [2,3].

In general, insufficient care is taken with asepsis at insertion, and/or with care of the insertion site and with administration of medications and nutrition, increasing potential for CLABSI, antibiotic exposure, length of stay, healthcare costs, and mortality [4,5]. Risk factors associated with CLABSI include duration of catheterization, location of the catheter, use of parenteral nutrition and multi-lumen catheters, experience of healthcare personnel, inadequate barrier precautions, type of dressings, care after insertion, and the presence of systemic sepsis or central venous catheter (CVC)-related thrombi [6–8].

Therefore, care bundles have been developed that address many of these factors. These have, however, been associated with variable success, perhaps because efficacy appears to be related to overall compliance with each element of the bundle, and this is not always audited and monitored [9,10].

In general, CLABSI rates vary among institutions and within units in the hospital as described recently, where, after implementation of bundles, CLABSI incidence still varied considerably although infections did decrease from a median of 6.4 (interquartile range: 3.8–10.9) to 2.5 episodes per 1000 catheter-days (1.4–4.8) [9].

Successful implementation of any bundle requires that measures be embedded, recorded, evaluated, and followed to ensure compliance by all participants and recognition that by reducing sepsis, patient safety is improved and antibiotic consumption reduced [11].

The 'Best Care Always!' (BCA) campaign was launched in South Africa in August 2009 with the aim of reducing the most frequent preventable HCAI as far as possible [11]. This initiative was voluntary and driven by a small committee of individual health professionals. Thereafter frontline health professionals were recruited from the private and subsequently the public sector. The BCA campaign was endorsed by private hospital groups as well as by the National Department of Health. The process involved implementation of quality improvement methodology and one or more of the infection bundles as published by the USA Institute of Healthcare Improvement (IHI) '100,000 lives' and the Canadian 'Safer Healthcare Now' campaigns [12,13]. All materials for implementation were freely available on the BCA website which was funded by Discovery Health, a South African Healthcare funder (http://www.bestcare.org.za). Private hospital groups (including Netcare) implemented these bundles using internal resources as part of their annual quality improvement and nursing budget, and in individual hospital budgets in terms of time allocated for training and implementation. In the public sector, the BCA committee of professionals supported formal learning sessions for some provincial hospital initiatives.

This article describes the implementation and impact of a bundle to reduce CLABSI in the Netcare group of private hospitals in South Africa.

Methods

This study took place over the period from April 2010 to May 2016. Certain process measures that have previously been associated with a reduction in CLABSI were identified and introduced in a stepwise fashion to the Netcare group of hospitals over this period [14]. A CLABSI was defined as a primary bloodstream infection occurring in a patient with a central line *in situ*; or where infection occurred within 48 h of the removal of the line and no other source of the bloodstream infection was identified.

The staged implementation of the intervention occurred over 74 months and the results were retrospectively recorded and linked to the interventions used. Bundles were selected from the IHI and Canadian 'Safer Healthcare Now' campaigns as described above.

Ethics approval was obtained from Pharma Ethics; Registration number: 161115386.

Introduction of the CLABSI bundle

Phase 1: April 2010 to March 2011. Infection prevention and control (IPC) officer-driven change

The process was initiated following commitment from hospital management and doctors to the principles espoused by BCA as detailed on the BCA website (www.bestcare.org.za). Thereafter training and guidelines were provided to dedicated IPC nurses at each hospital by the National IPC Manager for Netcare hospitals who also served on the BCA infection prevention working group. All Netcare hospitals were required to implement the CLABSI bundle in at least one unit and to expand implementation over time. No additional staff were employed at hospital level. The intervention was actively supported by Netcare leadership and a National IPC manager and IPC Specialist nurse who were in overall management of the BCA initiatives.

This specific intervention did require additional time allocation, initially by the IPC staff, but it was then incorporated into the daily nursing care programme. Ongoing monitoring was also integrated into the hospital IPC nurses' roles and responsibility.

The initial interventions were focused on familiarizing ICU unit managers and staff with the measurement of central-line-days and bundle implementation through training sessions, use of BCA posters in ICU wards, and implementation of a central-

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line bundle checklist. The elements of the bundle consisted of: hand hygiene, maximal barrier precautions on insertion, chlorhexidine skin antisepsis, optimal selection of the catheter site, and daily review of the necessity of the CVC (Appendix A, Supplementary Table I online).

Over the initial six or seven months IPC nurses measured compliance with checklists, central-line-days and incidence of infections per 1000 central-line-days. This became standard practice at Netcare Hospitals and the data were captured monthly into the central hospital database. Regional meetings of IPC nurses reinforced the interventions and difficulties and successes were discussed. Feedback was provided to nursing leaders and hospital management and the process gradually extended to all ICU units.

Compliance with each element of the bundle was measured separately and overall compliance calculated as a percentage of all five. These data were collated across all hospitals and represented on a run chart according to BCA methodology [11,15]. Having documented the extent of the problem, a goal was set to improve the measured parameters across all hospitals.

Phase 2: April 2011 to March 2012. Breakthrough collaborative method

Phase 2 was initiated using the 'breakthrough collaborative method' [16]. Nursing leaders, IPC nurses and ICU unit managers attended multiple regional learning sessions and undertook to lead the improvement by engaging with frontline staff and doctors. Regional meetings were organized through regional hospital and nursing managers with the support of the Director of Quality Systems and Innovation (QI Director). They were led by national and regional nursing leadership, the IPC national manager, the national Infection Prevention Specialist and the QI Director as needed. This approach was based on building skills in quality improvement methodology and was adopted from methods previously successfully employed by BCA and IHI workshops, in which the potential for improvement was highlighted and evidence provided confirming the efficacy of the bundle including studies such as the Keystone project [12,17,18].

The Plan–Do–Study–Act (PDSA) worksheet was used to document a test of change. Multiple PDSA cycles [development of a plan to test a change (Plan), carrying out the test (Do), observing and learning from the consequences (Study), and determining what modifications should be made to the test (Act)] were encouraged [19].

Compliance with the CLABSI bundle was included in the standard ICU chart to facilitate data collection. Further support to the regions was provided by a second senior experienced IPC nurse appointed to the Netcare IPC central team. In addition, Netcare supply companies were required to include insertion checklists into standardized central line packs. BCA bundle training was included in orientation sessions for new staff and reinforced in formal in-service training.

Data were collated for individual hospitals and for the hospital group, and graphs were made available on the Netcare intranet for local, regional, and national feedback and also by means of regional face-to-face learning and feedback sessions as well as larger teleconferences. Audits were performed initially by IPC nurses; thereafter this became the responsibility of ICU managers and samples were validated by the IPC nurses. In addition, peer-audits were performed annually by independent IPC experts. Staff were kept engaged in the process through sharing of audit and surveillance data in the form of run charts on staff notice boards and by leadership walkabouts and team meetings. Underperforming teams were monitored and supported more directly by the national IPC manager and by regional nursing leadership. The feedback showcasing results encouraged healthy competition between hospital teams.

Phase 3: April 2012 to May 2016. Sustained goal setting, benchmarks, and ongoing audits

This phase was subdivided into two parts (3a and 3b) to demonstrate the ongoing reduction in CLABSI that occurred in the latter part of this phase (3b) from July 2013 to May 2016 despite no new specific interventions. This illustrated that CLABSI prevention had become embedded in hospital practice.

In the initial part of this phase (3a) numerous interventions were embarked upon:

1. April 2012: bundle compliance and outcome data added to the Netcare hospital Quality Assurance audits.
2. April 2012: regional learning sessions with nurse leaders and IPC nurses continued, facilitated by two newly appointed quality improvement advisors.
3. April 2012: staff encouraged to present abstracts of BCA improvement projects for Netcare Quality Leadership Awards and the BCA quality improvement summit.
4. July 2012: BCA neonatal CLABSI bundle launched and led by a QI advisor and neonatal ICU managers.
5. January 2013: annual targets set for each hospital to allow year-on-year benchmarking of CLABSI rates and bundle compliance.
6. 2014 and 2015: introduction of an electronic IPC system that captured device days, laboratory and IPC data, allowing rapid review of outliers.

Statistics

The median CLABSI rates per 1000 central-line-days were calculated. The first median was calculated based on the first 12 data points and thereafter the median was recalculated each time there were six consecutive points above or below the median. Mean compliance and CLABSI rates were compared between periods by the independent samples *t*-test. The 5% significance level was used, adjusted for multiple comparisons.

Results

Data were collected from April 2010 until May 2016. The number of ICU and high-care beds varied within the study from 1397 to 1700 and from 439 to 493, respectively (Appendix A, Supplementary Table II online) due to additional hospitals being added to the group over this period. Overall this study recorded 1,119,558 central-line-days.

Following introduction of the BCA interventions, bundle compliance improved significantly from a mean of 73.1% [standard deviation (SD): 11.2; range: 40.6–81.7%] in Phase 1 (April 2010 to March 2011) to a mean of 90.5% (SD: 4.7; range: 76.5–97.2%) from July 2013 to May 2016 ($P = 0.0004$) (Table I).

Concurrently the CLABSI rate declined significantly from a mean of 3.55 (SD: 0.82; range: 2.54–5.78) per 1000 central-line-days in the period April 2010 to March 2011 to a mean of

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Table I
Differences in the mean compliance (absolute and relative)

Periods compared	Change in mean (absolute %)	Change in mean (%)	*P*-value
Phase 1 (Apr 2010 to Mar 2011) vs Phase 2 (Apr 2011 to Mar 2012)	9.1	12.5	0.024
Phase 2 (Apr 2011 to Mar 2012) vs Phase 3a (Apr 2012 to Jun 2013)	3.6	4.4	0.0038
Phase 3a (Apr 2012 to Jun 2013) vs Phase 3b (Jul 2013 to May 2016)	4.6	5.4	<0.0001

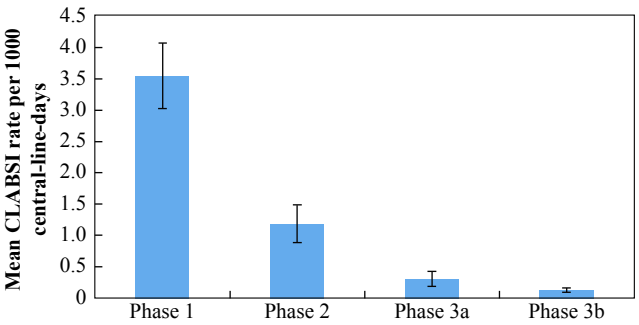

Figure 1. Mean central-line-associated bloodstream infection (CLABSI) rate for each of the four periods. Error bars denote 95% confidence interval for the mean.

0.13 (SD: 0.09; range: 0–0.33) in the period July 2013 to May 2016 ($P < 0.0001$) (Figure 1 and Table II).

The reduction corresponded reasonably well with the interventional phases described above and this can be seen graphically in Figure 2. The relationship is not exact due to interventions occurring at different times in each hospital and a delay in seeing a response to the change.

Discussion

This study is the first of its kind in South Africa and differs from many others in that it measured compliance with a bundle and associated that with a significant decrease in CLABSI. Over the period of nearly six years there was a significant improvement in compliance (from a mean of 75% to a mean of 96%) which was associated with a profound 95.5% reduction in CLABSI rate, emphasizing the importance of sustained compliance to each element of the bundle. It also illustrates that didactic lectures or instructions to follow a certain strategy are, by themselves, insufficient to facilitate change. Importantly the remarkable reduction in CLABSI would likely have had a substantial impact on patient safety and would potentially have impacted on other parameters such as mortality, antibiotic use, length of stay and cost.

In South Africa IPC has not traditionally been seen as integral to safe, effective frontline clinical care; however, this study emphasized that such a process may be advanced by motivation of the nursing leadership and supported by IPC nurses. Why did this intervention work? We believe that it was primarily by using quality improvement methodology (as modelled by other countries), motivation of staff, and a more focused use of existing resources. Specific interventions, particularly those described in the 'breakthrough series collaborative' are essential to ensure informed and enthusiastic involvement of all participants in the ICU, as without this the results are generally disappointing, as seen in a recent survey and in Phase 1 of this study in which only the IPC nurse was involved [10,16].

There have been many studies looking at the implementation of bundles in both high- and low-resource countries, and the most successful are those where there is involvement of the whole healthcare team along with strong leadership, strict protocols, measurement of checklist compliance, and involvement of nurses empowered to stop the procedure if protocols are breached [9]. However, we believe that the role of behavioural and improvement science skills, beyond the development of protocols and the use of checklists alone, cannot be underestimated if sustainable success is to be achieved [16,20]. This consists of thorough audit followed by learning cycles which are repeated as required, once the model has been entrenched. Thereafter, both for sustainability and to promote further improvements, leadership qualities must be cultivated and feedback on compliance and the effect on CLABSI rate provided to all hospitals. This latter promotes healthy competition between hospitals, another important stimulus to achieve these ends.

The necessity to collect and act on data is the first critical component of quality improvement. Change cannot occur without initially documenting the problem. The painstaking record-keeping of the past has been considerably assisted by the availability of software designed specifically for this purpose (such as the Bluebird electronic IPC system), and by allocation of unit managers and dedicated IPC personnel to collect and capture data [21].

Table II
Differences in the mean CLABSI rate (absolute and relative)

Periods compared	Change in mean (absolute): CLABSI per 1000 central-line-days	Change in mean (%)	*P*-value
Phase 1 (Apr 2010 to Mar 2011) vs Phase 2 (Apr 2011 to Mar 2012)	−2.36	−66.6	<0.0001
Phase 2 (Apr 2011 to Mar 2012) vs Phase 3a (Apr 2012 to Jun 2013)	−0.88	−74.1	<0.0001
Phase 3a (Apr 2012 to Jun 2013) vs Phase 3b (Jul 2013 to May 2016)	−0.18	−58.4	0.0069

CLABSI, central-line-associated bloodstream infection.

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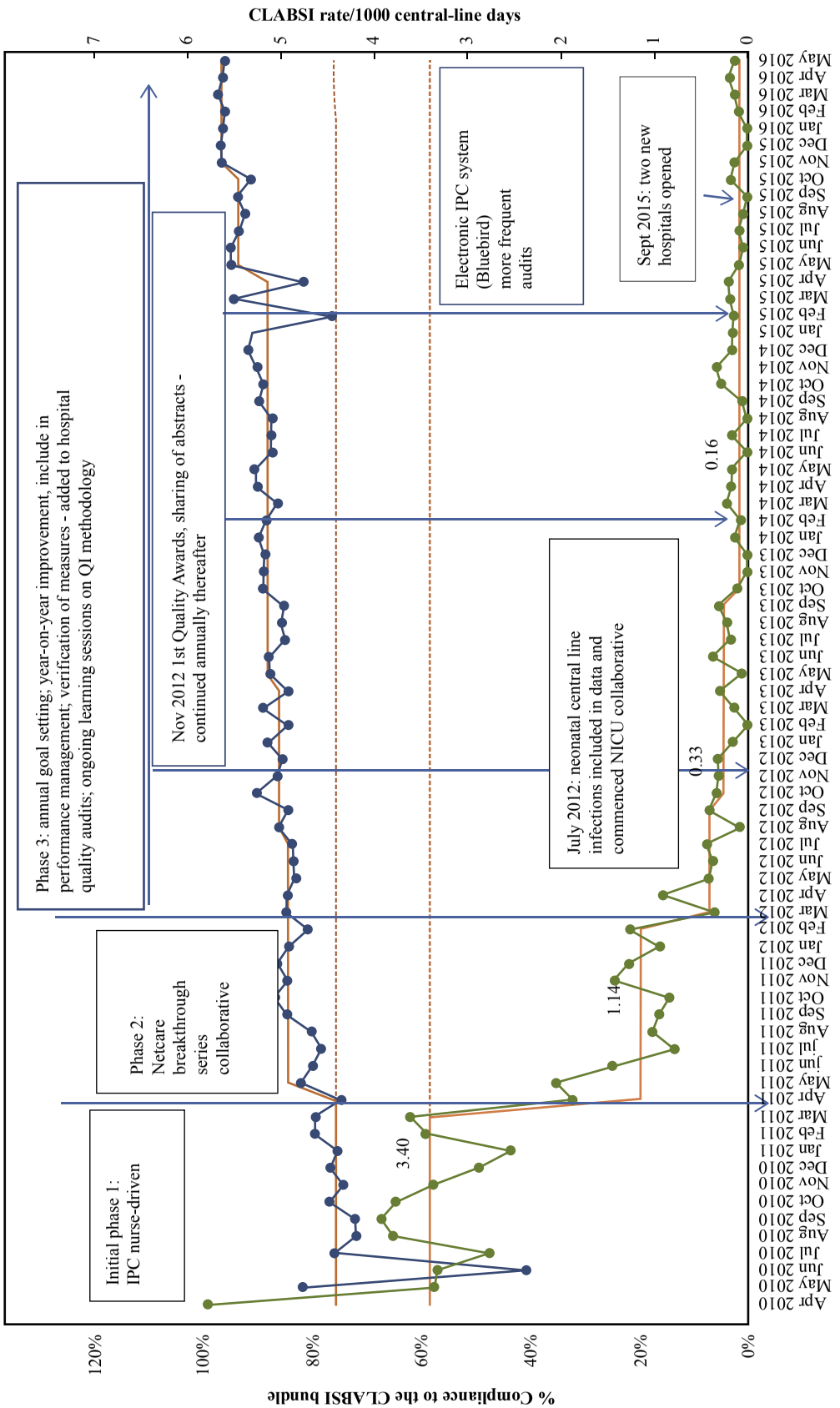

Figure 2. Compliance and central-line-associated bloodstream infection (CLABSI) rate with interventions, April 2010 ($N = 47$) to May 2016 ($N = 49$). IPC, infection prevention and control; QI, quality systems and innovation; NICU, neonatal intensive care unit.

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This intervention might be seen as resource intensive; however, available staff were used more efficiently through the process measures described above. The project was a collaborative between nursing leadership and the Quality Improvement team in the Quality Systems and Innovation department which included the Director of Quality Systems and Innovation (overall leadership of the project), Nursing leadership (national and regional leadership), the National IPC Manager, and Information Systems Support. No new staff were employed. The time allocated for the development of the database to support collation of data was not calculated, however. Nevertheless we believe that all hospitals should, as an initial step, perform audits using existing staff and this could provide the impetus to introduce further interventions such as these, even if initially only in a localized setting. For this to occur successfully in all hospitals in South Africa, data collection systems, sufficient IPC practitioners, dedicated clinical pharmacists, and 'champions' among the clinical staff should be available. Monitoring of CLABSI incidence is mandatory in many countries internationally and there is no reason that this should not be the standard operating procedure even in those that have lesser resources [22]. The BCA approach has already been introduced in relatively low-resource settings at some state hospitals, and, whereas collation of data is challenging, it may be facilitated through existing systems and more agile and affordable technology such as a mobile phone app. The bundles have also been incorporated into the National Core Standards for Hospitals in South Africa and therefore auditing of these will become mandatory.

Whereas proprietary chlorhexidine-impregnated dressings and other more specialized interventions such as antibiotic coating may reduce CLABSI, they are expensive and seem to add little to a CLABSI bundle that has been well integrated into the ICU [23,24]. It is also possible that these devices may lead to complacency and a reduction in attention to detail with regard to compliance with bundles.

There are limitations to the study, specifically that, although compliance and CLABSI were measured, other parameters that would have been valuable — such as impact on length of stay, mortality, antibiotic use and economic impact — were not. Nor did we calculate additional costs that would accrue, but these may well have been offset against a decrease in HCAI. This was, however, beyond the scope of this study. In addition, this study was carried out in the relatively well-resourced private sector and, although a beginning has been made in certain academic hospitals in the public sector, a national roll-out would be more difficult.

In conclusion, this study highlighted an unmet need, even in relatively well-resourced South African hospitals, concerning control of HCAI such as CLABSI, and that this can be considerably modified by relatively simple interventions. It is critical that this form of intervention be carried to all hospitals in the region. This is an essential component of antimicrobial stewardship with regard to decreasing antibiotic consumption and perhaps to rates of resistance in sub-Saharan Africa.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jhin.2017.05.013.

Conflict of interest statement
None declared.

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