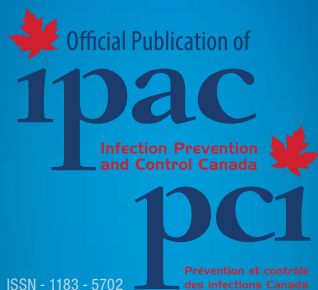


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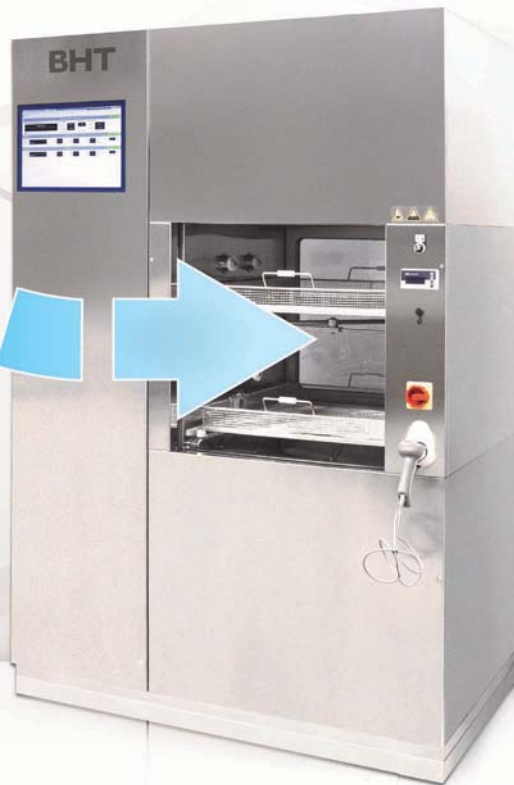
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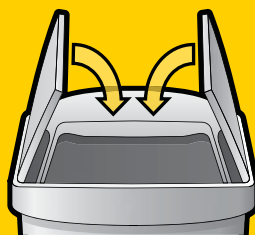
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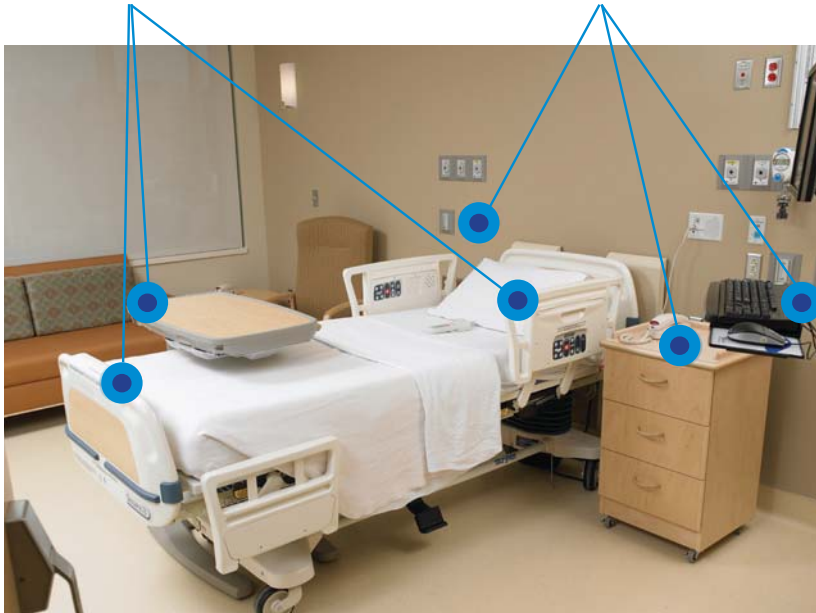
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Correlation between hand hygiene compliance and methicillin-resistant *Staphylococcus aureus* incidence

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ABSTRACT

Background: The objectives of the study are to investigate the relationship between hand hygiene compliance and hospital-acquired methicillin-resistant *Staphylococcus aureus* (MRSA) incidence, and to propose a new method for estimating Pearson correlation between pair of rates.

Methods: 2011-2014 hand hygiene audit data were linked to hospital-acquired MRSA data in the province of Alberta, Canada. Hand hygiene compliance and hospital-acquired MRSA incidence rates were calculated at the unit, site, zone and provincial levels. Pearson correlation coefficients were calculated for the pairs of the rates. The 95% confidence limits of the Pearson correlation coefficients were estimated based on the information contained in hospital-acquired MRSA incidence rates.

Results: Strong longitudinal correlations between hospital-acquired MRSA incidence and hand hygiene compliance were found at the provincial level and for the Calgary Zone and Edmonton Zone (<-0.95). At the site level, a strong correlation was found for the Foothills Medical Centre (-0.88).

Conclusion: Combining the traditional Pearson correlation technique with the proposed inference method provides a simple and proper method for detecting the relationship between healthcare-acquired infection and hand hygiene.

KEY WORDS:

Correlation study; Hand hygiene; Incidence; Infection; Methicillin-resistant *Staphylococcus aureus*; Statistical method

INTRODUCTION

In Canada, more than 200,000 patients acquire an infection each year while receiving healthcare, and more than 8,000 of these patients die from such infections (1). As a result, eliminating healthcare-acquired infections has become a key priority for healthcare quality and patient safety programs (2).

Methicillin-resistant *Staphylococcus aureus* (MRSA), the most common cause of serious healthcare-acquired infections (3) is a bacterium that is resistant to many antibiotics. In healthcare facilities MRSA can cause life-threatening bloodstream infections, pneumonia and surgical site infections. The overall incidence of both MRSA colonization and MRSA infection increased 19-fold in Canadian hospitals from 1995 to 2009(4).

Hand hygiene is a strategy for preventing hospital-acquired infections including MRSA. Alberta Health Services (AHS)

conducted provincial wide hand hygiene compliance audits from 2011. To investigate the relationship between hand hygiene compliance and hospital-acquired MRSA incidence, hand hygiene compliance audit data and hospital-acquired MRSA surveillance data collected by AHS were linked.

AHS is Canada's first and largest province-wide, fully integrated healthcare system, which has 106 acute care hospitals, five stand-alone psychiatric facilities, 8,471 acute care beds, 23,742 continuing care beds/spaces, 208 community palliative and hospice beds, 2,439 addiction and mental health beds plus equity partnerships with 42 primary care networks. AHS is organized into five geographic zones: South, Calgary, Central, Edmonton and North. Hand hygiene and hospital-acquired MRSA data used for this study are from acute care facilities across the five zones that have both hospital-acquired MRSA surveillance data and hand hygiene compliance audit data.

Acknowledgement

The authors thank the Department of Analytics of Alberta Health Services (AHS) for providing assistances with patient-days data acquisitions, and the staff at the Department of Infection Prevention and Control of AHS for collecting MRSA infection cases and performing hand hygiene compliance audits.

Pearson correlation coefficients between annual hand hygiene compliances and hospital-acquired MRSA incidence rates were calculated at unit, site, zone and provincial levels. Due to the small sample sizes (4 pairs of annual rates) the results were unreliable. Therefore, a new method to estimate confidence limits of the Pearson correlation coefficient is proposed.

METHODS

Data collections and linkages

Hand hygiene compliance for nurses, physicians and other healthcare providers in acute care units were observed by trained auditors between May and August using the direct observation method for the “Four Moments for Hand Hygiene” (5, 6) from 2011 to 2014. Auditors received standardized training on conducting audits and were guided by an Infection Control Professional mentor at each site. Auditors and mentors met often to discuss difficult cases and to review methodology to improve inter-rater consistency.

Province-wide surveillance for hospital-acquired MRSA cases began in January 2010. All patients admitted to one of AHS’ acute care or acute tertiary rehabilitation care facilities that had a newly identified positive MRSA cultures were included in the surveillance. Hospital-acquired MRSA (colonized and infected) is defined as those cases that have been identified after the patient has been admitted >48 hours in an AHS facility or have been admitted for <48 hours prior to identification of an MRSA, but the patient had a previous acute care admission from the same or different AHS facility within 14 days.

Unit-based patient-days were derived from the Admission, Discharge and Transfer (ADT) databases maintained by the Analytics department of AHS for the period of January 2011 to December 2014. Unit-level elapsed patient-days, the exact length of stay in a unit, were calculated for each patient stay in an acute care facility operated by AHS. Elapsed patient-days calculated from the ADT databases are accurate to the minute.

Annual hand hygiene compliance audit data were first merged with denominator (patient-days) data by unit. The units which did not participate in provincial hand hygiene audits were excluded. Then hospital-acquired MRSA data were merged with denominator data which had been linked to hand hygiene data at the unit level. Using the linked data, hand hygiene compliance, hospital-acquired MRSA incidence and their 95% confidence limits were calculated at the unit, site and zone levels. If there were no hospital-acquired MRSA cases, the rates were set to zero.

The entire patient-days for the hospitalized patients, rather than the patient-days at risk of acquiring a MRSA, were used as the denominators of hospital-acquired MRSA incidences. Because the patients infected or colonized with hospital-acquired MRSA during their unit stays were fewer than other patients in the units, the slight underestimates were ignored.

Rates and confidence limits

With traditional correlation analysis, all variables are assumed to have no measurement error. In fact, very often variable measurements include errors and these errors may vary

from measurement to measurement (7). Due to potential measurement errors, hand hygiene compliance rates may vary with approximately normal distribution since their sample sizes were large (≥ 10). The 95% confidence limits for the rates were calculated with: $p \pm 1.96 \sqrt{p(1-p)/n}$, where p is the hand hygiene compliance rate and n is the number of hand hygiene observations.

Hospital-acquired MRSA (colonization and infection) incidences may also vary due to potential measurement errors. Because the numbers of hospital-acquired MRSA cases are smaller, hospital-acquired MRSA incidences usually do not satisfy the normal approximation of the distribution, especially at the unit level. Assuming that the hospital-acquired MRSA cases had a Poisson distribution and the number of patient-days were fixed, the 95% confidence limits were estimated for each of the calculated hospital-acquired MRSA incidence rate by using the following formulae (8) based on the relation between the Poisson distribution and chi-square distribution (9,10):

Lower Limit = $10,000 \times CINV(0.025, 2 \times \text{case}) / (2 \times PD)$
and

Upper Limit = $10,000 \times CINV(0.975, 2 \times \text{case} + 2) / (2 \times PD)$

where $CINV$ is a SAS function which returns the $\alpha/2$ th (0.025) and $(1 - \alpha/2)$ th (0.975) quantiles from the chi-squared distribution with degrees of freedom $2 \times \text{case}$ and $2 \times \text{case} + 2$ respectively, case is the number of hospital-acquired MRSA cases and PD is patient-days. Significance level α was 0.05. Because the unit of hospital-acquired MRSA incidence we used was per 10,000 patient-days, a constant of 10,000 was multiplied.

The ratio of the relative variation (RRV) for each hospital-acquired MRSA incidence to the hand hygiene compliance was calculated using the equation below:

$$RRV = \frac{\frac{\text{Upper limit of MRSA incidence} - \text{Lower limit of MRSA incidence}}{\text{MRSA incidence}}}{\frac{\text{Upper limit of hand hygiene compliance} - \text{Lower limit of hand hygiene compliance}}{\text{Hand hygiene compliance}}}$$

Correlation coefficients and confidence limits

Because the hand hygiene compliance rates were based on larger numbers in the numerators and denominators, the compliance rates were more stable than hospital-acquired MRSA incidence rates. For simplicity, we assume that hand hygiene compliance rates are fixed and hospital-acquired MRSA incidence rates vary randomly. Under this assumption, the real hospital-acquired MRSA incidence rates would be some values between the lower and upper confidence limits of the calculated rates with a 95% probability.

Longitudinal Pearson correlation coefficients between hospital-acquired MRSA incidence and hand hygiene compliance were calculated at the unit, site, zone, and provincial levels. For each of the calculated correlation coefficient between the rates, $2^4 = 16$ different Pearson correlation coefficients were calculated by using lower limit or upper limit values of the four annual hospital-

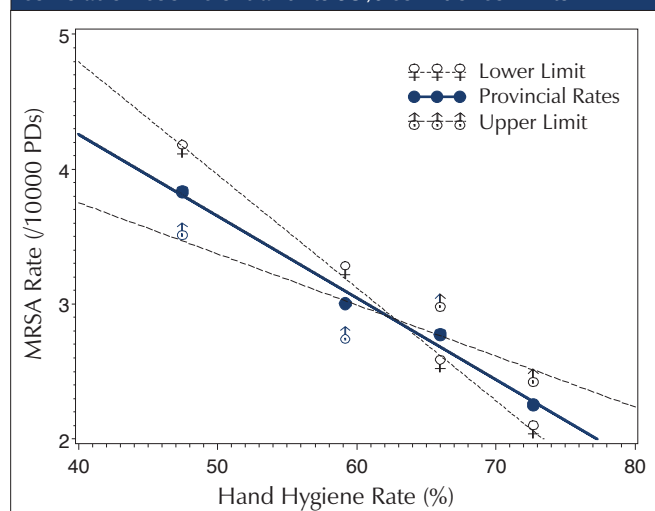
acquired MRSA incidences. The smallest and largest ones among the 16 correlation coefficients were considered to be the lower and upper confidence limits of the corresponding correlation coefficients between the rates, respectively. If the lower and upper limits have the same direction (positive or negative), the correlation coefficient was considered to be statistically significant (i.e., null hypothesis can be rejected).

As an example, Figure 1 depicts the scatterplot for provincial hospital-acquired MRSA incidence versus hand hygiene compliance and the regression line. The data points for the upper and lower limits of each hospital-acquired MRSA incidence versus hand hygiene compliance are also shown in the figure. Two other regression lines (dotted lines) with the largest and smallest slopes in the figure were derived by exchanging the upper and lower limits of 2011 and 2012 hospital-acquired MRSA incidences. The corresponding correlation coefficients are the upper and lower confidence limits of the provincial correlation coefficient.

This study focused on longitudinal analyses because the cross-sectional scatterplots for zone, site, and unit hospital-acquired MRSA incidence versus hand hygiene compliances for each year had no significant linear correlation between the two rates due to the diversity of the rates.

All calculations were performed using SAS version 9.3 (SAS Institute Inc., Cary, NC).

FIGURE 1: Annual provincial hospital-acquired methicillin-resistant *Staphylococcus aureus* (MRSA) incidence (/10,000 patient-days) versus hand hygiene compliance with the regression lines for estimating the correlation coefficient and its 95% confidence limits



RESULTS

Table 1 shows zone and provincial hospital-acquired MRSA incidences and hand hygiene compliances for 2011, 2012, 2013 and 2014. In 2011, the Central Zone hospital-acquired MRSA incidence was much higher (5.80/10,000 patient-days) than those in other zones (1.23-4.39/10,000 patient-days). The Central Zone hospital-acquired MRSA incidence dramatically

decreased to 3.55/10,000 patient-days in 2012, which was comparable with other zones. During the four years, North Zone consistently had the lowest annual hospital-acquired MRSA incidences (0.95-1.23/10,000 patient-days). Hospital-acquired MRSA incidences for South, Calgary, and Central zones, and the whole province decreased consistently over the years, while hand hygiene compliances for South Zone, Calgary Zone and the province increased gradually. Hand hygiene compliance for Central Zone did not increase obviously.

Table 1 also shows the 95% confidence limits for the annual hospital-acquired MRSA incidences and hand hygiene compliances for the zones and the province. The ratios of the relative variations (RRV) for hospital-acquired MRSA incidence to hand hygiene compliance ranged from 4.4 to 34.5 (not shown in the table). Because all RRVs >4, it is reasonable to assume that the hand hygiene compliances are fixed, and only the hospital-acquired MRSA incidence rate vary. Taking into account the variation of the hand hygiene compliance rates, the confidence intervals would be a little boarder than those estimated by the proposed method. We tested the differences by using the confidence limits for the hand hygiene rates instead of the rates themselves to calculate the confidence limits of the correlations with the same method, no obvious differences were found in our data.

Longitudinal Pearson correlation coefficients between hospital-acquired MRSA incidence and hand hygiene compliance were calculated for 93 units, 26 sites, 5 zones and the whole province. There are not enough data points for estimating correlations for those units or sites which participated in the provincial hand hygiene audits later than 2011 or had one or more zero annual MRSA rates during the study period.

The correlation coefficients, *P*-values generated by SAS PROC CORR (11) and their confidence limits derived with the proposed method for a selected unit and hospital, for each zone and the whole province are shown in Table 2. Based on the *P*-values and upper confidence limits, Calgary Zone, Edmonton Zone and the whole province had strong negative correlations between MRSA incidence and hand hygiene compliance (<-0.95). At the site level, a negative correlation (-0.88) between hospital-acquired MRSA incidence and hand hygiene rate was found at the Foothills Medical Centre, the largest hospital in Alberta (1,063 beds), with the proposed method (upper limit < 0). This correlation could not be detected by using the traditional method (*P*=0.116). Given the small number of MRSA cases per unit, only six significant correlations were found at the unit level with traditional method (*P*<0.05, only one unit was shown in the table). These are likely due to chance. These correlations lose significance when the proposed method was applied.

For a relationship to exist between MRSA and hand hygiene compliance, there must be significant number of MRSA cases occurring in the site. This means that detection of a significant relationship between MRSA and hand hygiene rates is generally restricted to tertiary or large urban centres. Of the 106 hospitals in AHS, only 5 (4.7%) hospitals have > 500 beds and only 17 (16.0%) hospitals have > 250 beds. The remainders of the hospitals vary from 5 to 249 beds with the majority < 100 beds.

TABLE 1: Hospital-acquired methicillin-resistant *Staphylococcus aureus* (MRSA) incidence and hand hygiene compliance by zone and year

Zone	Year	No. Sites	No. Units	MRSA				Hand Hygiene		
				No. Cases	Patient Day (PD)	Rate (/10,000 PDs)	95% Confidence Interval	Number Observed	Rate (%)	95% Confidence Interval
South	2011	10	26	70	159,312	4.39	3.43, 5.55	2,471	57.75	55.80, 59.70
	2012	11	29	72	165,389	4.35	3.41, 5.48	14,192	67.67	66.90, 68.44
	2013	11	34	75	187,656	4.00	3.14, 5.01	15,999	77.58	76.93, 78.23
	2014	11	35	46	211,142	2.18	1.60, 2.91	16,656	79.76	79.14, 80.37
Calgary	2011	11	59	191	537,045	3.56	3.07, 4.10	7,640	40.07	38.97, 41.16
	2012	11	61	176	588,486	2.99	2.57, 3.47	10,840	49.95	49.01, 50.90
	2013	12	75	150	646,502	2.32	1.96, 2.72	14,532	60.55	59.75, 61.34
	2014	12	100	181	877,026	2.06	1.77, 2.39	19,911	66.61	65.96, 67.27
Central	2011	21	35	122	210,418	5.80	4.81, 6.92	1,993	66.53	64.46, 68.60
	2012	24	60	127	357,634	3.55	2.96, 4.23	4,940	58.00	56.62, 59.37
	2013	25	63	130	374,913	3.47	2.90, 4.12	11,502	63.86	62.98, 64.74
	2014	25	67	95	374,120	2.54	2.05, 3.10	8,663	67.74	66.75, 68.72
Edmonton	2011	10	91	228	587,474	3.88	3.39, 4.42	5,892	41.38	40.12, 42.64
	2012	11	98	213	667,025	3.19	2.78, 3.65	8,262	59.27	58.21, 60.33
	2013	11	110	225	718,992	3.13	2.73, 3.57	6,812	55.59	54.41, 56.77
	2014	11	113	210	754,521	2.78	2.42, 3.19	12,625	74.15	73.38, 74.91
North	2011	11	16	18	146,460	1.23	0.73, 1.94	1,890	62.70	60.52, 64.88
	2012	31	37	25	262,887	0.95	0.62, 1.40	4,305	55.61	54.13, 57.09
	2013	21	40	29	267,102	1.09	0.73, 1.56	5,728	64.16	62.92, 65.40
	2014	31	40	31	282,170	1.10	0.75, 1.56	9,781	75.56	74.71, 76.42
Province	2011	63	227	629	1,640,710	3.83	3.54, 4.15	19,886	47.46	46.76, 48.15
	2012	88	285	613	2,041,421	3.00	2.77, 3.25	42,539	59.18	58.71, 59.65
	2013	90	322	609	2,195,165	2.77	2.56, 3.00	54,573	66.00	65.60, 66.40
	2014	90	355	563	2,498,980	2.25	2.07, 2.45	67,636	72.69	72.36, 73.03

TABLE 2: Correlation between annual hospital-acquired methicillin-resistant *Staphylococcus aureus* (MRSA) incidence and hand hygiene compliance, and the confidence limits calculated with the proposed method

		Correlation Coefficient	P-value	Lower Limit	Upper Limit
Selected Unit	Unit 102 at Foothills Medical Centre	-0.9902	0.0098	-0.9909	0.8538
Selected Site	Foothills Medical Centre	-0.8837	0.1163	-0.9838	-0.1015
Zone	South	-0.7133	0.2867	-0.9321	0.2262
	Calgary	-0.9984	0.0016	-0.9994	-0.7194
	Central	0.1048	0.8952	-0.4176	0.4356
	Edmonton	-0.9595	0.0405	-0.9810	-0.1069
	North	0.3843	0.6157	-0.6995	0.9394
Province		-0.9929	0.0071	-0.9983	-0.8910

DISCUSSION

Why a new method?

While there are many measures of association for rates, correlation is the most commonly used approach. However, correlation technique treats the rates as fixed numbers irrespective of whether the rates are derived from millions of observations or from only a few observations (all sample sizes for our annual rates are 4). Using the traditional method, the

information contained within the rates is ignored and the results are misleading.

At the unit level, traditional correlation analyses do not provide consistent or robust results, given the small number of MRSA cases per unit. For instance (Table 2), the General Surgery and Medical Oncology Unit (Unit 102) at Foothills Medical Centre had similar correlation coefficients between the rates ($r=-0.9902$, $P=0.0098$) to those derived from the provincial

rates ($r=-0.9929$, $P=0.0071$). Based on the traditional Pearson correlation technique the former is significant, but probably due to chance. The numbers of hospital-acquired MRSA cases annually collected from Unit 102 were 6, 5, 4 and 2 for 2011, 2012, 2013 and 2014 respectively. Potential measurement errors may make the real number of cases one case more or less than those collected. In this case, a small amount of variation in the case numbers can introduce a large difference in the hospital-acquired MRSA rate and in the correlation.

In Table 2, most of the P -values derived with traditional method are consistent with the confidence limits derived with the proposed method. For example, Calgary Zone has a correlation coefficient $r=-0.9984$ with $P=0.0016$. Its lower and upper limits are negative. Both the results indicate that the correlation coefficient is statistically significant. However, for Foothills Medical Centre and its Unit 102 the results are contradictory. The P -value is based on four pairs of annual rates and used for inferring the correlation result to large population, while the confidence limits are derived from hospital-acquired MRSA incidence rates (which are based on larger number of observations) and used for estimating the variation of the rates due to potential measurement errors. Since the rates were collected from most of the acute care units in Alberta, the results do not need to be inferred to a larger population. Therefore, instead of P -values, the confidence limits derived by the proposed method can be used to determine the significances of the correlation coefficients between the rates.

Time-series analyses would be appropriate to analyze time trends in MRSA in relation to hand hygiene compliance. However, this would require a larger number of data points (e.g., quarterly data on MRSA acquisitions and hand hygiene). Only annual data were available for this study.

Previous correlation studies

Because longitudinal data are difficult to collect, reports using correlation analyses with short time sequences are limited. The most common methodologies used for determining the relationship between hand hygiene interventions and the incidence of healthcare-acquired infections were before-and-after observational studies (12, 13). Sroka et al. (14) conducted a systematic review for published before-and-after observational studies. They used the results of six selected studies to detect the relationship between the percent difference of hand hygiene compliance and the percent difference of MRSA before and after the intervention with Spearman correlation test, and concluded that there was no correlation between hand hygiene compliance and MRSA, although the amount of alcohol-based hand rub use was related to MRSA ($r=0.778$, $P=0.014$, 9 studies).

Other researchers have also used correlation test to estimate the relationship between hand hygiene and MRSA (15-17). Matsumoto et al. (15) reported a Pearson correlation between increased use of alcohol-based hand rub and decreased MRSA incidence ($r^2=0.58$). Glove use was also negatively correlated with MRSA ($r^2=0.68$). Zahar et al. (16) detected a marginally significant negative correlation between hand hygiene compliance and MRSA incidence ($r=-0.51$, $P=0.055$).

Jayaraman et al. (17) did not find a significant correlation between the rates of hand hygiene and MRSA, partially due to their extremely small sample size for hand hygiene data (20 observations each month). All these correlation analyses were based on a few pairs of rates while taking no account of the information contained in the rates (i.e., magnitudes of numerators and denominators of the rates). If the proposed method were used, the results would be different.

To our knowledge, the proposed methodology is an initial approach for correlation analysis in the area of healthcare epidemiology or applied statistics. Traditional approach to confidence interval estimation (18, 19) uses Fisher's Z transformation (20) of the observed correlation coefficient to construct a confidence interval around the correlation coefficient. This confidence interval is based on the errors that occurred when taking samples from a larger population. Charles (21) suggested an alternative approach to interval estimation, which estimates both sample errors and measurement errors simultaneously. The proposed method, which estimates measurement errors only, is an appropriate method for correlation analysis with data from a whole population.

Limitations

Pearson correlation analysis only looks at the linear relationship between hand hygiene and healthcare-acquired infections. It cannot detect non-linear relationships or multiple effects. MRSA infections have numerous affecting factors, such as a patient's comorbidities, invasive procedures, prior colonization, length of hospital stay and antimicrobial use, not only hand hygiene compliance. As infections can vary greatly with type, source, and severity, examining the MRSA incidence rate needs to include various contributing factors in patient condition and hospital services. Correlation techniques do not consider the complicating factors of MRSA infection and prevention, which may explain why a strong drop in MRSA rate was observed in Central zone despite the fact that hand hygiene level remain the same. Regression analyses would be more powerful if more data were available.

Another limitation of this correlation analysis is the inability to distinguish between explanatory and response variables. It is possible that healthcare providers may have better hand hygiene compliance than they would normally have if the unit has higher hospital-acquired MRSA incidence rates, as they are more likely to be reminded more often and are generally more aware of their own practices. This could explain why the relationship between MRSA incidence and hand hygiene compliance could not be detected from our data using a cross-sectional approach.

CONCLUSIONS

Combining the traditional Pearson correlation technique with the proposed inference method provides a simple and proper method for detecting the longitudinal relationship between healthcare-acquired infection and hand hygiene compliance rates. With the proposed method, information contained in the rates can be fully used for analysis. By using Pearson correlation technique with the proposed inference method we have found

strong negative relationships between hospital-acquired MRSA incidence and hand hygiene compliance longitudinally with statistical significance at provincial, zone and site levels. We did not find any significant correlations at the unit level due to the smaller numbers of MRSA cases. Although correlation analysis has a few limitations, it is a useful technique to detect the relationship between the rates. As the creators of the novel methodology, we expect that the method will be widely used to estimate correlations between any short rate (or mean) series with potential measurement errors and not restricted to hand hygiene and healthcare-acquired infection data.

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The effect of timing of oseltamivir chemoprophylaxis in controlling influenza A H3N2 outbreaks in long term care facilities in Eastern Manitoba, Canada, 2014-2015: A retrospective cohort study

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ABSTRACT

Background: Influenza is a major cause of morbidity and mortality in long term care (LTC) facilities. The Infectious Diseases Society of America (IDSA) recommends the use of oseltamivir for chemoprophylaxis during outbreaks, but the evidence supporting its use in this setting is not strong. As well, the impact of timing of chemoprophylaxis in this setting has not been evaluated.

Objective: This study examined the effect of the timing of administration of oseltamivir chemoprophylaxis for the control of influenza A H3N2 outbreaks among residents in LTC facilities in Manitoba, Canada during the 2014-2015 influenza season, after controlling for other institutional factors.

Methods: We conducted a retrospective cohort study of all influenza A H3N2 outbreaks occurring in LTC facilities in the region during the 2014-2015 influenza season. Given the lack of independence of outcomes in an institutional setting, a hierarchical logistic regression analysis was conducted.

Results: 13 outbreaks occurred in LTC facilities in the region during this time. After exclusion criteria were applied, 11 outbreaks with 610 residents were included in the analysis. The time, measured in days, from the day of the second case to the start of oseltamivir chemoprophylaxis was the only significant variable in both the univariate (OR: 1.596, 95% CI: 1.058 – 2.410, $t = 2.57$, $df = 9$, $p = 0.03$), and adjusted models (OR: 1.513, 95% CI: 1.136 – 2.016, $t = 3.53$, $df = 6$, $p = 0.01$).

Conclusion: The data indicate that the sooner chemoprophylaxis is initiated, the lower the odds of secondary infection with influenza in long term care facilities during outbreaks caused by influenza A H3N2 in Manitoba.

KEY WORDS:

Influenza, long term care, oseltamivir, prophylaxis, prevention

INTRODUCTION

Influenza is a major cause of morbidity and mortality in Canada, accounting for an estimated 12,000 hospitalizations and 3,500 deaths every year [1]. It also disproportionately affects certain population sub-groups, with the elderly being affected particularly severely [1]. Every year, long term care (LTC) facilities in Manitoba experience outbreaks of influenza.

The standard of care in Manitoba LTC facilities during outbreaks partially follows the recommendations of the Infectious Diseases Society of America (IDSA) [2, 3]. Specifically, all symptomatic residents receive 5 days of oral oseltamivir at the therapeutic dose and all other residents receive 10 days of oseltamivir chemoprophylaxis at the prophylactic dose [2]. Though the IDSA guideline recommends different neuraminidase

inhibitors depending on the strain of influenza detected [3], all influenza outbreaks in LTC facilities are controlled with oseltamivir [2]. In 2014-2015, the province administered over 50,000 doses of oseltamivir for chemoprophylaxis [4]. Given extensive reliance on this single intervention and its significant cost, the evidence of its effectiveness should be convincing. However, the original studies cited for IDSA recommendations [5-10], and those published since the recommendations [11-13], have multiple flaws undermining the strength of evidence.

In 2009, the IDSA published its guidelines for the treatment and prevention of influenza in children and adults [3]. It concluded that all residents in LTC facilities should be given oseltamivir or zanamivir for chemoprophylaxis if two or more residents became ill with an influenza-like illness (ILI) within 72 hours and influenza

A H3N2 virus or influenza B virus was detected in the facility [3]. All six of the studies informing the guideline report a benefit of oseltamivir in controlling influenza outbreaks, though one was just a descriptive study [5-10]. However, the three studies published since the release of the guideline have had more ambiguous results, with one study reporting a benefit [11], one reporting mixed results [12] and another reporting no significant benefit [13]. The IDSA reported the level of evidence for its recommendation as I-A [3], or evidence derived from a systematic review of randomized controlled trials – the highest level of evidence available for recommendations. None of the studies specifically looked at the impact of timing of oseltamivir chemoprophylaxis on the secondary attack rate in LTC facilities.

Our study examined the effect of the timing of administration of oseltamivir chemoprophylaxis for the control of influenza A H3N2 outbreaks among residents in LTC facilities in Manitoba, Canada during the 2014-2015 influenza season, after controlling for other institutional factors.

METHODS

This was a retrospective cohort study. As part of delivering health care in Manitoba, all LTC facilities monitor for ILI. Nursing staff at each facility complete an influenza preparation toolkit each October and are instructed to keep watch for respiratory symptoms in residents. If an institutional ILI outbreak is detected, nasopharyngeal swabs are collected on all ill residents to identify the causative organism. Staff are instructed to keep records of daily case counts and symptoms present during outbreaks to monitor their development and resolution. An institutional influenza outbreak is defined as “Two or more cases of ILI (including at least one laboratory – confirmed case) occurring within a seven-day period in an institution” [2]. Influenza is detected by either growth on viral culture, detection of amplified nucleic acid or detection of viral antigen from a clinical sample [2]. We contacted one of the rural Regional Health Authorities in Manitoba to obtain the epidemic curves for all influenza A outbreaks in LTC facilities in the region during the 2014-2015 influenza season. Outbreaks were excluded from the analysis if they had incomplete epidemic curves. Only the first outbreak in an institution was included in the analysis as a prior outbreak during the same influenza season may significantly alter the immunity of the residents to the circulating strain of influenza thus affecting the attack rate.

Data Analysis

For each outbreak, the data was analyzed at the individual and institutional level by using a hierarchical logistic regression model with Laplace Maximum Likelihood approximation. The number of days until oseltamivir prophylaxis was started was calculated by determining the date of chemoprophylaxis and subtracting the date that the second person became ill in the institution. The number of days that passed from the second case of ILI until an outbreak was declared was calculated for each institution and used as a control variable. Other control variables included the number of days between declaring an outbreak and the start of oseltamivir chemoprophylaxis, the number of days between the first and second cases, the prevalence of symptomatic infection at

the start of the outbreak, and the number of at risk individuals at the start of the outbreak.

First, an empty model was used to determine the intra-class correlation (ICC). Then, the six independent variables listed above were included in the model as level 2 (institutional level) variables and individually modeled with the outcome variable. They were then added in a stepwise forward modelling strategy to determine the best multiple variable main effects model, including both statistically significant and clinically significant variables. The continuous variables were then assessed for linearity to determine if any variable transformations were needed. As well, model variables were assessed for co-linearity. Next, the final main effects model was assessed for any significant interactions between the time to oseltamivir prophylaxis and other main effects model variables. All analyses were conducted at an alpha level of 0.05.

RESULTS

There were 13 outbreaks in the region during the 2014-2015 influenza season. One of the outbreaks was excluded due to an incomplete epidemic curve and another was excluded since it was not the first outbreak of the season at that institution. Eleven outbreaks were included with a total population at risk of 610 residents (Table 1).

First, the ICC was calculated to determine if hierarchical logistic regression was needed to analyze this data set. With a covariance of 1.11 for the intercept in the empty model, the ICC was 25%. Therefore, the outcomes of infection were significantly correlated with the institutions that the residents resided in and hierarchical logistic regression was needed to analyze this data. If hierarchical analysis was not used, the data analyzed would be at the level of the institution as seen in Figure 1.

Next, a single variable hierarchical logistic regression analysis was done. Among the six independent variables examined, only the number of days that passed between the second case and the start of chemoprophylaxis ($t = 2.57$, $df = 9$, $p = 0.03$), and the number of individuals at risk at the start of the outbreak ($t = 2.60$, $df = 9$, $p = 0.03$) were statistically significant (Table 2). Due to their perceived potential clinical importance, the number of days between the first and second case, and the prevalence of influenza were included in the final model despite not being statistically significant. The number of days between the second case and starting chemoprophylaxis remained statistically significant throughout the analysis to the final model ($t = 3.53$, $df = 6$, $p = 0.01$) (Table 2). The number of days between the second case and declaring an outbreak, and the number of days between declaring an outbreak and starting chemoprophylaxis were not significant at any time during the analysis. As well, since these two times add up to the same amount of time as the number of days between the second case and starting chemoprophylaxis, they could not all be used in the model at the same time.

After checking all the variables in the final model for linearity, all variables were determined to be linear.

There were no significant interactions between the number of days to influenza chemoprophylaxis and any of the three other variables in the final model.

TABLE 1: Outbreak Characteristics by Institution

Outbreak	# of Cases	Total # of Residents	2 ^o Cases	Residents excluding 1 ^o cases ¹	2 ^o attack rate (%)	Days till chemoprophylaxis ²	Days ₁₋₂ ³	Days to OB ⁴	Prev of Flu (%) ⁵
1	14	80	10	76	13.2	3	0	2	5
2	14	20	12	18	66.7	8	0	5	10
3	8	50	6	48	12.5	3	1	2	4
4	7	76	5	74	6.8	4	1	3	3
5	12	30	10	28	35.7	5	0	4	7
6	7	20	4	17	23.5	2	1	1	15
7	7	104	5	102	4.9	5	3	2	2
8	6	40	2	36	5.6	4	1	2	10
9	16	91	5	80	6.3	3	0	2	12
10	40	79	27	66	40.9	5	0	1	16
11	6	20	4	18	22.2	5	1	0	10

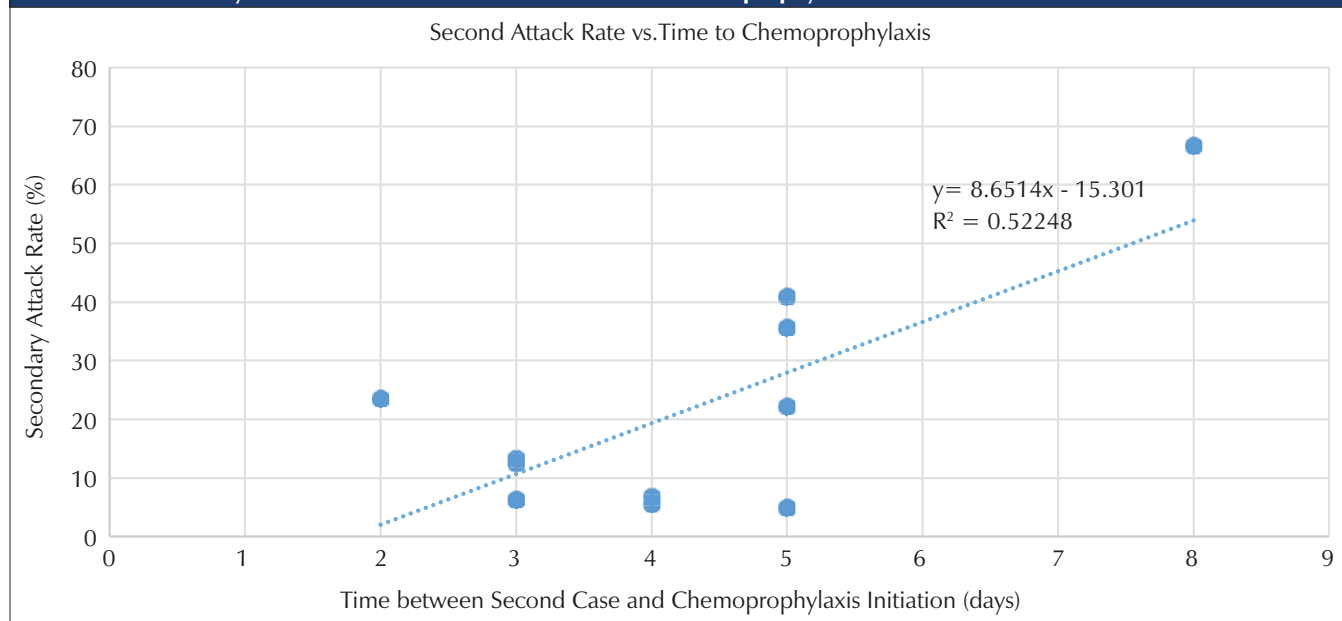
¹ Primary cases are defined as cases occurring on or before the day that the second case occurred

² Number of days between the second case and start of chemoprophylaxis

³ Number of days between the first and second cases

⁴ Number of days between the second case and declaring an outbreak

⁵ Prevalence of influenza in the institution at the start of the outbreak

FIGURE 1: Secondary attack rate vs time from second case to chemoprophylaxis

DISCUSSION

These data indicate that the sooner chemoprophylaxis is initiated, the lower the odds of secondary infection in LTC facilities during outbreaks caused by influenza A H3N2 in Manitoba.

The 2009 IDSA guidelines reference six studies for its recommendation to use oseltamivir in LTC facility prophylaxis [3]. Between 2009 and 2015, three more studies were published on this topic. However, there are several problems with these studies. First, two of the studies were based on average households [5, 9]. An average household contains

mostly children and young to middle aged adults. This population is very different from that of a LTC facility and the immunogenicity of the elderly is very different from that of younger individuals [3]. The ability to fight the infection and respond to prophylaxis may be very different in the elderly. Therefore, the findings in these studies have limited applicability to the elderly population in LTC facilities.

Second, one study used a significantly different duration of prophylactic intervention [7]. Oseltamivir prophylaxis was given for 6 continuous weeks in the experimental group and not given to the

TABLE 2: Univariate and Final Model Predictor Odds Ratios for Influenza Infection

Independent Variable	Model Predictions for Influenza Infection	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI) ¹
Days between Second Case and Chemoprophylaxis	1.596 (1.058 – 2.410)	1.513 (1.136 – 2.016)
Days between First and Second Case	0.477 (0.225 – 1.010)	0.633 (0.376 – 1.067)
Days between Second Case and Declaring an Outbreak	1.343 (0.763 – 2.364)	-
Days between Declaring an Outbreak and Chemoprophylaxis	1.344 (0.790 – 2.284)	-
Prevalence of Influenza at Start of Outbreak	1.125 (0.972 – 1.301)	1.051 (0.961 – 1.149)
Number of At Risk Individuals at Start of the Outbreak	0.975 (0.954 – 0.997)	0.989 (0.974 – 1.004)

¹ (-) indicates that this variable was not included in the final model

control group. So, though the study had a randomized design, the intervention is not comparable to only giving oseltamivir for 10 days once an outbreak has begun, as is the practice in Manitoba.

Third, the five remaining studies had small numbers of outbreaks. The number of outbreaks ranged from 3 to 15 [6, 10-13]. The study with 15 outbreaks, the largest number for comparison, represents the one study that showed no difference between the infection rate in the placebo and intervention groups [13]. Though the authors note that even that study was under-powered to detect a significant difference. The study with the smallest number of outbreaks had a mixed result in terms of whether oseltamivir prevented infection.

Lastly, two studies did not separate the analysis of the results by influenza strain [11, 13]. This is problematic because oseltamivir has varying levels of activity *in vitro* depending on the strain of influenza [14].

This study has several advantages over previous studies. All outbreaks were caused by the same strain of influenza. The information was available to calculate the number of secondary cases. Vaccination was not a confounder because the vaccine was shown to have limited efficacy against influenza A H3N2 during the 2014-2015 season [15]. The analysis was done at the institutional and individual levels, and the study used several control variables to limit confounding.

Several limitations should be noted. The sample size was small, with only 11 outbreaks. Therefore, the study was not sufficiently powered to exclude a type 2 error for those variables that were found to be not statistically significant. Information about the demographics of the residents in each LTC facility was not obtained to determine if there were significant differences among the residents of the various institutions. This could confound the relationship examined. There could also be significant differences in how these various facilities are run with respect to infection prevention and control (IP&C) of communicable diseases. Better run facilities may have better outbreak detection systems and better trained staff. We have attempted to control for some of these potential differences, but others may not be accounted for and may represent an unmeasured source of bias. There could have been measurement errors if individuals were infected with other respiratory viruses after the start of the outbreak and assumed to be infected with influenza.

Given these limitations, this study still adds support for the prompt administration of oseltamivir for chemoprophylaxis in influenza A H3N2 outbreaks in LTC facilities. However, more research must be done to better estimate the magnitude of this relationship.

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Epidemiologic characteristics of *Klebsiella pneumoniae* isolates in ventilator-associated pneumonia in intensive care units

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ABSTRACT

Background: *Klebsiella pneumoniae* is a common pathogen that causes ventilator-associated pneumonia (VAP) in intensive care units (ICUs). Strain typing is a useful tool in tracking the spread of these infections. Primary objective was to study the different *K. pneumoniae* strains causing VAP in Anesthesia ICUs, Zagazig University Hospitals, Egypt. Secondary objective was to determine the role of healthcare workers (HCWs) and ICU environment in the transmission of these strains.

Methods: Endotracheal aspirates of 60 VAP patients were collected. Surveillance samples were collected from the HCWs and the ICU environment. Antibigram typing and enterobacterial repetitive intergenic consensus-polymerase chain reaction (ERIC-PCR) were used for comparison of the isolates from the surveillance samples and VAP patients. Antibigram showed five antibiotic susceptibility patterns that were designated A1-A5.

Results: All five patterns showed multidrug resistance (MDR) as strains were resistant to five or six antibiotics. ERIC-PCR yielded one to five amplification bands. All the isolates were typable by this method. Eight ERIC patterns were obtained ERIC(I)-ERIC(VIII). ERIC-PCR typing method gave higher discriminatory index (D) (0.7557) than antibiogram (0.6035). Sharing of certain ERIC patterns among patient strains may be explained by horizontal transmission from patient to another patient, probably from the hands of HCWs or environmental sources.

Conclusion: *K. pneumoniae* is the most dominant member of pathogens in Zagazig University hospitals anesthesia ICUs. Throats and hands of HCWs are possible sources of pathogen transmission to the ICU patients. Surfaces with hand contact of the medical staff are often contaminated and may serve as vectors for cross transmission.

KEY WORDS:

Ventilator-associated pneumonia, ICU environment, healthcare workers, *Klebsiella pneumoniae*, antibiogram typing, ERIC-PCR

INTRODUCTION

Ventilator-associated Pneumonia (VAP) is defined as pneumonia occurring more than 48 hours after the initiation of endotracheal intubation and mechanical ventilation (MV) (1).

It is one of the most frequent intensive care unit (ICU)-acquired infections, occurring in 10-20% of patients intubated for longer than 48 hours (2). Several studies have shown that critically ill patients are at high risk for getting such infection and so it continues to be a major cause of morbidity, mortality and increased financial burden in ICUs (3).

Healthcare workers (HCWs), contaminated equipment, and the ICU environment have been implicated in healthcare-associated outbreaks. *Klebsiella pneumoniae* is very well adapted to the hospital environment since it exhibits higher survivability on hands and environmental surfaces than other *Enterobacteriaceae* (4). Cross-transmission can also occur from patient to patient via hands of the HCWs (5).

Strain typing by traditional phenotypic methods may lack discriminatory power and stability. Molecular techniques offer a considerable improvement, and can complement phenotypic data to obtain a better understanding of bacterial diversity (6).

Enterobacterial repetitive intergenic consensus-polymerase chain reaction (ERIC-PCR) is a simple, high throughput,

affordable, reproducible, and discriminatory molecular typing method. Furthermore, it has excellent subtyping results and does not require much skill to perform (7). The success of it as a simplified typing strategy makes it a tenable one for hospital-based epidemiology (8).

METHODS

Study design and setting

This prospective study was conducted in Medical Microbiology and Immunology Department and Anesthesia Intensive Care Units (ICUs), Zagazig University Hospitals. There are 15 beds separated by curtains in each of the two anesthesia ICUs with adequate space for movement of staff and equipment.

Ethical consideration

Approval for performing the study was obtained from the Institutional Review Board (IRB).

Study population

This study included 60 patients who were suspected clinically to have ventilator-associated pneumonia (VAP). Demographic and procedure-related information was collected. Patients who developed VAP within the first four days of MV were classified as

early-onset VAP, while those who developed VAP at five or more days after the initiation of MV were classified as late-onset (9).

Collection of samples

According to the method described by (10), EA samples were collected from the patients early in the morning as they contain pooled overnight secretions in which pathogenic bacteria are more likely to be concentrated. Samples were collected, before starting antibiotic treatment whenever possible by suctioning 1-10 ml of purulent secretions from the endotracheal tube. Then the part of the suction catheters containing the aspirates were cut and placed in screw-capped, sterile, wide-mouthed plastic containers.

Throat swabs from healthcare workers (HCWs) and environmental samples were collected throughout the ICUs and streaked out. HCWs were requested not to take any antibiotic or mouthwashes eight hours before swabbing (11). For the settle plates method, samples were collected from air in the ICUs starting from June 2013 during collecting the patients' samples, by agar settle plates method, where blood agar plates were left open to the air according to the 1/1/1 scheme (for one hour, at a height of one meter at least one meter from walls) (12) and compared to other plates left open for 24 hours (13).

Hand impressions

They were requested to press their fingers onto blood agar plates. Sampling was performed at midday, by which time staff members had been in contact with patients for several hours (3).

Sample processing

Endotracheal aspirates were examined microscopically by Gram's stain and 10 μ L were streaked on MacConkey medium in four quadrants consecutively, then incubated at 37°C for 24 hours. Interpretation was as the following; growth was classified as rare (1+), light (2+), moderate (3+), or heavy (4+), based on the number of colonies in each quadrant, (3+) grade was considered diagnostic for VAP (14). Microbiological confirmation of suspected VAP cases was based on a positive Gram stain (≥ 25 pus cells/low power field and ≥ 1 bacteria/oil immersion field) (15) and semi-quantitative endotracheal aspirate (EA) cultures of moderate (3+) or heavy growth (4+), where (3+) is equivalent to quantitative culture showing $\geq 10^5$ colony forming unit (CFU)/ml (1).

Throat swabs of healthcare workers were streaked out on blood agar and MacConkey agar plates. Then, they were incubated aerobically at 37°C for 24 hours (16). Blood agar plates of hands impression were also incubated at 37°C for 24 hours (3).

Environmental swabs were streaked out on blood agar and MacConkey agar plates. Then, they were incubated aerobically at 37°C for 24 hours (16). Blood agar plates of air samples were also incubated aerobically at 37°C for 24 hours (13).

Maintenance of the selected isolates

The selected isolates that fulfilled the criteria of being *K. pneumoniae* were inoculated on nutrient agar slopes. After an overnight incubation at 37°C, the slopes were kept at 4°C. Subculturing of the isolates was done every 2-3 weeks. Also,

before starting any experiment, subculture was done twice to allow the cells to restore its viability.

Antibiotic susceptibility testing

Antibiogram typing was performed by the Kirby-Bauer disc diffusion method (17). The diameters were interpreted as Resistant, Intermediate, Susceptible) according to CLSI published diameters (18).

ERIC-PCR typing

For comparison of the isolates from the surveillance samples and VAP patients, Enterobacterial repetitive intergenic consensus-polymerase chain reaction (ERIC-PCR) was used. DNA extraction was done using G-spin™ Total DNA Extraction Mini Kit (iNtRON Biotechnology, Korea). ERIC-PCR were performed using PCR Premix (iNtRON Biotechnology, Korea). Two primers were used (Biologio, Netherlands); ERIC1 and ERIC2 were designed according to (19). ERIC-PCR were performed in a final volume of 20 μ L containing 2 μ L of the template DNA, 1 μ L of primer ERIC1R (10pmol/ μ L), 1 μ L of primer ERIC2 (10pmol/ μ L), 16 μ L Distilled Water. Each reaction mixture was amplified with a heated lid thermal cycler (Biometra, UK).

Reaction conditions were as follows: 94°C for 1 minute, followed by 35 cycles at 94°C for 30 seconds, 25°C for 30 seconds, 72°C for 1.5 minutes, and a final extension at 72°C for 10 minutes (20).

The amplified PCR products were visualized by agarose gel electrophoresis as described by (21). Molecular size marker gave 11 bands ranging from 100-1500 base pairs (bp).

RESULTS

The study was conducted on 60 patients admitted to the ICUs and diagnosed as having VAP. They were 34 males and 26 females and their ages ranged from 18 to 75 years old ($X \pm SD$: 49.05 \pm 14.8).

The figure (1) shows the result of cultivation of 60 patients' endotracheal aspirates. The study showed that the frequency of *K. pneumoniae* isolation from VAP patients was 39% and that of HCWs throat and hand samples was 16.7% and 11.1% respectively. Regarding environmental and air samples, frequency of isolation was 24.6% and 25% respectively. Highest frequencies of *K. pneumoniae* isolation from environmental samples were from ventilator tube (44%), humidifier fluid (44%) and ventilator screen (32%).

K. pneumoniae isolates were mostly sensitive to imipenem (89.4%), amoxicillin/clavulanic acid (89.4%), colistin (89.4%) and amikacin (71.1%) followed by ciprofloxacin (48.7%) and ceftazidime (46.1%). On the other hand, they were all resistant to ampicillin, ceftriaxone, cefotaxime and tobramycin. Antibiogram showed 5 antibiotic susceptibility patterns that were designated A1-A5. All the five patterns showed multidrug resistance (MDR) as strains were resistant to five or six antibiotics (Figure 2).

ERIC-PCR yielded one to five amplification bands. The size of amplified DNA bands ranged from 100 bp to 1000 bp. All the isolates were typable by this method. Eight ERIC patterns were obtained ERIC(I)-ERIC(VIII) (Table 1).

ERIC-PCR typing method gave higher discriminatory index (D) (0.7557) than antibiogram (0.6035) (Table 2).

By analyzing ERIC-PCR typing data, possible epidemiological linkages were proven (Table 3). There was sharing of certain ERIC patterns among patient strains. A direct link among two hand strains, two throat strains and two patients' strains, belonging to ERIC(VI) genotype was proven. In addition, a direct link among one throat strain and four patients' strains, belonging to ERIC(I) genotype was proven.

Ventilator tubes, humidifier fluid and ventilator screen had a central role in the spread of *K.pneumoniae* in the ICU

where epidemiological linkage was proven among patients and ventilator tubes by harboring strains belonging to ERIC(I), ERIC(III), ERIC(IV), ERIC(V) and ERIC(VIII) genotypes (Table 1).

DISCUSSION

Ventilator-associated pneumonia (VAP) is one of the most frequent intensive care unit (ICU)-acquired infection, occurring in 10-20% of patients intubated for longer than 48 hours (2).

In spite of significant changes in the spectrum of organisms causing VAP, *Klebsiella pneumoniae* has held a nearly unchanged position as an important pathogen (22).

In a World Health Organization (WHO) cooperative study involving 55 hospitals in 14 countries, there was a predominance of Gram-negative pathogens causing VAP, *K. pneumoniae* was diagnosed in 40% of cases (23).

With the rising spread of antibiotic-resistant organisms, laboratories must focus more on the epidemiology of healthcare-associated infections (HAIs). Strain typing is a useful tool in tracking the spread of these HAIs (24).

As the respiratory system is the primary settlement place of opportunistic organisms and considered as chief carrier of common respiratory pathogens, 17.6% of our study patients were not considered to have VAP, as the semi-quantitative cultures of their EA showed rare (1+) and light (2+) growth and hence they were considered colonized with Gram negative organisms.

It is relatively low when compared to (25) study results which showed that 55% of the patients were colonized with Gram negative organisms. This could be explained by the fact that most of the studied patients (85.7%) have been already taking antibiotics for more than 48 hours.

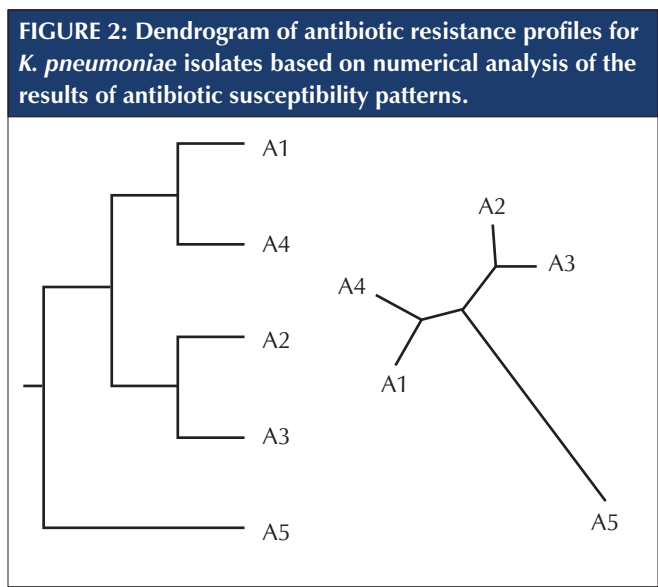
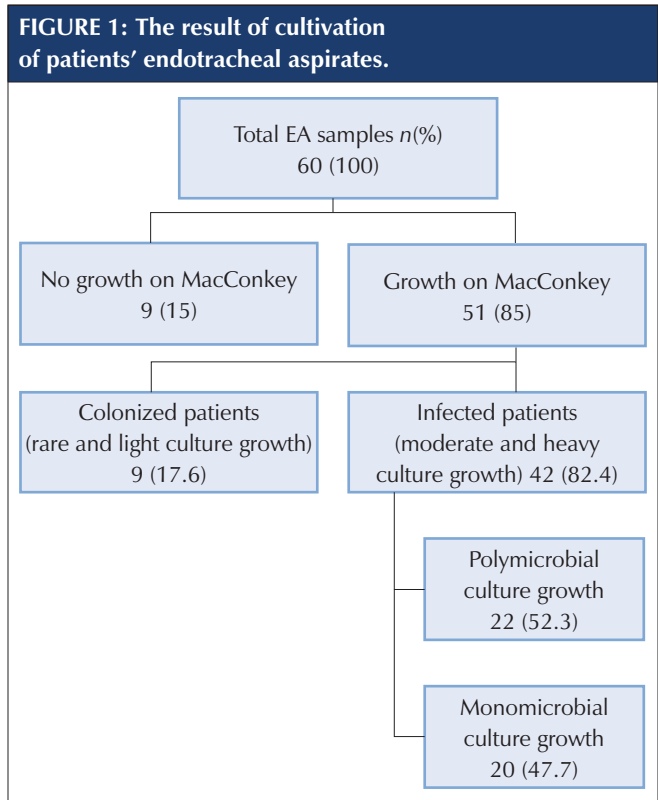


TABLE 1: Similarity Matrix computed with Dice coefficient for different observed ERIC-PCR patterns.

	I	II	III	IV	V	VI	VII	VIII
I	1	0.000	0.000	0.500	0.000	0.667	0.400	0.286
II		1	0.333	0.000	0.000	0.000	0.000	0.222
III			1	0.000	0.000	0.000	0.400	0.000
IV				1	0.000	0.667	0.000	0.000
V					1	0.000	0.000	0.000
VI						1	0.000	0.000
VII							1	0.500
VIII								1

TABLE 2: Comparison between antibiogram and ERIC-PCR.

	No. of different patterns	No. of strains belonging to the most numerous pattern	Numerical discriminatory index
Antibiogram	5	23	0.6035
ERIC-PCR	8	18	0.7557

TABLE 3: Epidemiological analysis of typing data.

Isolates	Source	Antibiotic pattern	ERIC pattern
p1, p4, p5, p16	Patient	1	I
e1, e5, e23, e28	Ventilator tube	1	I
e2, e6, e7	Humidifier fluid	1	I
e22, e30	Ventilator screen	1	I
t3	Throat	1	I
a1	Air	1	I
e12	Ventilator tube	1	II
e18	Humidifier fluid	1	II
e42	Over bed	1	II
p2, p3, p8, p10, p11, p17, p18, p21	Patient	2	III
e3, e32	Ventilator tube	2	III
e4, e14	Bed rail	2	III
e13, e16	Ventilator screen	2	III
e15	Over bed	2	III
e17	Suction apparatus	2	III
e31	Humidifier fluid	2	III
e38	Medicine trolley	2	III
p6, p12, p15	Patient	3	IV
e20, e26	Ventilator tube	3	IV
e10, e21, e27	Humidifier fluid	3	IV
e8	Ventilator screen	3	IV
e9	Suction apparatus	3	IV
p7, p13, p22, p23	Patient	4	V
e11, e40	Bed rail	4	V
e24	Medicine trolley	4	V
e36	Ventilator tube	4	V
e29, e35, e37	Humidifier fluid	4	V
e39	Suction apparatus	4	V
e41	Ventilator screen	4	V
p24, p25	Patient	4	VI
e43	Ventilator screen	4	VI
e44	Bed rail	4	VI
h1, h2	Hand	4	VI
a2	Air	4	VI
t1, t2	Throat	4	VI
e19	Over bed	4	VII
p9, p14, p19, p20	Patient	5	VIII
e25	Suction apparatus	5	VIII
e33	Ventilator screen	5	VIII
e34	Ventilator tube	5	VIII

p: patient endotracheal aspirate, e: environmental swab, t: throat swab of healthcare worker, h: hand impression of healthcare worker, a: air sample.

The infection was polymicrobial in 52.3% and monomicrobial in 47.7% of the patients. This result is in accordance with that of (26) in which 60% of their studied specimens contained more than one organism, but unlike that of (27) which was only 16.8%.

Research into the frequency of contact of ICU patients with the medical staffs revealed that the medical staffs were in direct contact with patients 159 times per day and experienced indirect contact with patients 191 times per day (28).

In this study, we expected that one of the possible causes of transmission of infection with *K. pneumoniae* to the ICU patients was HCWs, as the organism was isolated from 16.7% of their throat samples and 11.1% of their hand samples. This might be due to inadequate application of standard precautions for infection control and hand hygiene measures.

Gupta et al. also found a dominant strain of *K. pneumoniae* on the hands of two medical staff in their investigations into the outbreak of *K. pneumoniae* in a neonatal intensive care unit (NICU) (29).

Gram-negative species can survive on inanimate surfaces even for months. A high inoculum of the nosocomial pathogen in a cold room with high relative humidity will have the best chance for long persistence. In hospitals, a single hand contact with a contaminated surface results in a variable degree of pathogen transfer (30).

In the present study, the environmental sampling had shown that one-fourth (25%) of the samples were positive for *K. pneumoniae* which is slightly higher than the result of (31) which was 16.4%. This figure reflected the fact that *K. pneumoniae* is ubiquitous in the hospital environment.

Pinpointing the most important source of *K. pneumoniae* and targeting it has been done previously and showed favorable results. In a study by Narciso et al. (32) two strains were isolated from ventilator screen and suction device. *K. pneumoniae* was also isolated from 3.5% of suction apparatus samples and 5.6% of medicine trolley samples in NICU (33).

Das et al. (34) pointed out that the presence of this respiratory pathogen in air might be attributed to the bacterial aerosols generated due to coughing and sneezing.

A special focus has been placed on settle plates method by using the settle plates method being of low cost, easy application and usually valid outcomes. In addition, it has no effect on ventilation of the environment, and microorganism grow under the natural conditions. In the present study, no growth of *K. pneumoniae* obtained from agar plates after leaving them open for one hour, unlike obtaining two out of eight *K. pneumoniae* growth after leaving them open for 24 hours.

This finding matched with that detected by (35) who found that all air samples collected from NICU of Karnataka institute of Medical Sciences hospital in India were negative for *K. pneumoniae*, where the settle plates method was done using settle plates exposed to the NICU air for only half an hour.

In conclusion, this study has determined that *K. pneumoniae* is the most dominant member of pathogens in Zagazig University hospitals anesthesia ICUs. Throats and hands of HCWs are possible sources of pathogen transmission to the ICU patients. Surfaces with hand contact of the medical staff are often contaminated and may serve as vectors for cross transmission.

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Impact of a multidimensional International Nosocomial Infection Control Consortium (INICC) approach on ventilator-associated pneumonia rates and mortality in Intensive Care Units in a Malaysian hospital

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ABSTRACT

Background: To analyze the impact of a multidimensional infection control approach and the use of the International Nosocomial Infection Control Consortium (INICC) Surveillance Online System (ISOS) on the rates of ventilator-associated pneumonia (VAP) and mortality in Malaysia from November 2013 to July 2015.

Methods: A prospective, before-after study of 1,532 patients of 1 adult intensive care unit (ICU) and 1 pediatric ICU. During baseline, we performed outcome surveillance of VAP applying the CDC/NHSN definitions. During intervention, we implemented the INICC multidimensional approach and ISOS, including: 1) a bundle of infection prevention interventions; 2) education; 3) outcome surveillance; 4) process surveillance; 5) feedback on VAP rates and consequences; and 6) performance feedback of process surveillance. Bivariate and multivariate regression analyses were performed using a logistic regression model to estimate the effect of intervention on VAP.

Results: The baseline VAP rate of 27.2 per 1000 mechanical ventilator (MV)-days – with 956 MV-days and 26 VAPs–, was reduced to 12.9 –with 2,100 MV-days and 104 VAPs, showing a 53% VAP rate reduction (RR 0.47; 95%CI 0.27–0.81; P 0.006). The mortality rate of 18.8% was reduced by 40% to 11.2% (RR 0.60; 95%CI 0.41–0.86; P 0.005).

Conclusions: Implementing the INICC multidimensional infection control approach for VAP prevention was associated with a significant reduction in the rate of VAP and mortality in ICUs of Malaysia.

KEY WORDS:

Hospital infection; nosocomial pneumonia; developing countries; critical care; surveillance; bundle

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Author contributions: All authors were involved in study conception and design, drafting of the manuscript, provision of study patients, collection of data, critical revision of the manuscript for important intellectual content, and final approval of the manuscript. V.D.R. was responsible for software development; data assembly, analysis, and interpretation; epidemiologic analysis; statistical analysis; and technical support.

INTRODUCTION

Ventilator-associated pneumonia (VAP) is considered to be among the most serious device-associated infections (DAI) in the intensive care unit (ICU) setting (1, 2). According to studies from developed (3) and limited-resource countries (1, 4), the most important clinical consequences attributable to VAP are increased mortality rates (4), significant morbidity (5), and increased length of stay (LOS) (4). From an economic perspective, VAPs are also responsible for significant increases in healthcare costs, as reported in both developed (3) and limited-resource countries (4, 6, 7). The burden posed by VAP has not been systematically analyzed in limited-resource countries (1). Although hospitals in limited-resource countries do implement basic infection control programs, compliance with infection control practices is variable (1). As reported by the International Nosocomial Infection Control Consortium (INICC) in pooled studies (8-11) and in particular studies from Malaysia (12), the rates of VAP have been determined to be from 3 to 5 times higher than in the western countries (13).

In western countries, it has been shown that the incidence of VAP can be substantially prevented and reduced by more than 30% through basic but effective measures (1, 14) such as those described in the bundle for VAP prevention developed by the Institute for Healthcare Improvement (15): 1) Elevation of the Head of the Bed between 30 -45 degrees; 2) Daily Sedative Interruption and Daily Assessment of Readiness to Extubate; 3) Peptic Ulcer Disease Prophylaxis; 4) Deep Venous Thrombosis Prophylaxis; and 5) Daily Oral Care with Chlorhexidine.

The present study was designed to determine the effect of INICC multidimensional program for reduction of VAP rates and mortality in 1 adult ICU and 1 pediatric ICU of 1 hospital of Malaysia (16). Our program was implemented from November 2013 to July 2015 and included six simultaneous interventions: 1) bundle of infection prevention practices, 2) education, 3) outcome surveillance, 4) process surveillance, 5) feedback on VAP rates and consequences and 6) performance feedback of process surveillance.

At present, there is sufficient ethical and theoretical justification for conducting this particular study and through its publication increase and spread awareness on this public health burden in Malaysia.

METHODS

Background on INICC

Founded in Argentina in 1998, the INICC was the first multinational research network established to control and reduce healthcare-associated infections (HAIs) at international level through the analysis of data collected on a voluntary basis by a pool of hospitals worldwide (16, 17). The goals of the INICC include the development of a dynamic global hospital network that applies systematic surveillance of HAIs with standardized definitions and methodologies of CDC/NHSN (18, 19), promotion of evidence-based infection control practices, and performing applied infection control research to reduce rates of HAI, associated mortality, excess lengths of stay, costs and bacterial resistance (16)(20).

Setting and study design

This prospective, before-after study was conducted in one adult ICU and one pediatric ICU of an INICC member hospital in Malaysia. This hospital had been actively implementing the INICC Multidimensional Approach (IMA), as described below, during a three-month baseline period and subsequent intervention period, with an infection control team (ICT) comprised of infection control professionals (ICPs), and medical doctors with formal education and background in internal medicine, critical care, infectious diseases, microbiology, and/or hospital epidemiology.

The hospital's Institutional Review Board agreed to the study protocol, and patient confidentiality was protected by codifying the recorded information, making it only identifiable to the ICT.

Baseline period

The baseline period included only the performance of outcome surveillance and process surveillance. The length of the baseline period was set at three months, as it allowed us to reach the proper sample size and collect sufficient amount of data without compromising statistical characteristics of the study

Intervention period

The intervention period started in the fourth month of participation. This was a prospective cohort study, and each ICU joined the INICC program at different moments. Thus, by the time we analyzed the impact of the INICC intervention, we had ICUs with different lengths of participation in intervention periods. For the pediatric ICU, the baseline period was from 1 November 2013 to 31 January 2014, and the intervention period was from 1 February 2014 to 31 July 2015. For the medical/surgical ICU, the baseline period was from 1 March 2014 to 31 May 2014, and the intervention period was from 1 June 2014 to 31 June 2015.

INICC Multidimensional Approach

The IMA includes the implementation of CDC/NSHN's methodology, but adds the collection of other data essential to increase ICPs' sensitivity of to detect HAIs, and avoid underreporting (21). According to standard CDC/NSHN methods, numerators are the number of HAIs of each type, and denominators are device-days collected from all patients, as pooled data; that is, without determining the number of device-days related to a particular patient, and without collecting characteristics per specific patient (21). This design differs from the IMA, because the design of the cohort study through the INICC methods also includes collecting specific data per patient from all patients, both those with and those without HAI. As well, IMA collects risk factors of HAIs, such as invasive devices, and surrogates of HAIs, which include, but are not limited to high temperature, low blood pressure, results of cultures, antibiotic therapy, LOS and mortality. By collecting data on all patients in the ICU, it is possible to match patients with and without HAI by several patient characteristics (such as age and sex) to estimate extra LOS, mortality and cost.

The IMA comprises the simultaneous implementation of the following 6 components for HAI control and prevention: 1) a bundle of infection prevention practices, 2) education, 3) outcome surveillance, 4) process surveillance, 5) feedback on HAI rates and consequences, and 6) performance feedback (16).

1. **Bundle of infection prevention practices**

The bundles of infection prevention practices were designed following the recommendations and guidelines published by the Society for Health Care Epidemiology of America and the Infectious Diseases Society of America published in 2008 (22), and in 2014 (23), and the bundle for VAP prevention developed by the Institute for Healthcare Improvement in 2012 (15). These guidelines and bundle describe different recommendations for HAI prevention that are classified into categories regarding the existing scientific evidence, applicability and their prospective economic effects.

Components of INICC Infection

Control Bundle for VAP prevention(23)

Our bundle included the following 12 elements: i. Adherence to hand-hygiene guidelines; ii. Reduction of length of MV use; iii. Use of non-invasive ventilation whenever possible and minimization of the duration of ventilation; iv. Preferable use of orotracheal instead to nasotracheal intubation; v. Maintenance of an endotracheal cuff pressure of at least 20 cm H₂O; vi. Removal of the condensate from ventilator circuits; and keeping the ventilator circuit closed during condensate removal; vii. Change of the ventilator circuit only when visibly soiled or malfunctioning; viii. Avoidance of gastric overdistention; ix. Use of sterile water to rinse reusable respiratory equipment; x. Elevation of the head of the bed between 30-45 degrees; xi. Daily sedative interruption and daily assessment of readiness to extubate; and xii. Three-times-per-day comprehensive oral care with chlorhexidine.

2. **Education**

Education sessions were regularly provided to health care workers (HCWs) and included information about infection control measures specific for VAP prevention, based on the mentioned guidelines and recommendations, as well, and the correct procedures and technique for hand hygiene. Education sessions can be measured regarding its efficacy through its impact on rates of compliance with the bundle components. We consider the results process surveillance could have been achieved because HCWs had been trained and were aware of the fact that they were being observed when performing their practices to assess if the preventive measures of the bundle components were being complied with (24).

3. **Outcome surveillance**

Prospective outcome surveillance was conducted through an online platform called INICC Surveillance Online System (ISOS), whose effective impact on VAP rates reduction was shown in several studies (18, 25-31). The use of ISOS allowed the classification of prospective, active, cohort surveillance

data into specific module protocols that applied U.S. CDC/NHSN's definitions published in January 2013 (18).

It comprised 15 modules: 10 for Outcome Surveillance and five for Process Surveillance (16). The site-specific criteria included reporting instructions and provided full explanations integral to their adequate application (18).

4. **Process surveillance**

The process surveillance was performed through the ISOS modules, which included the monitoring of compliance with the 12 bundle elements for VAP prevention (16).

5. **Feedback on DA-HAI rates and consequences**

HCWs receive feedback on DA-HAI rates and their consequences at monthly meetings, by means of the review of reports generated through the ISOS (32), which contains charts and tables with a running record of the monthly data of cohort surveillance. This infection control tool is important to increase awareness about outcomes of patients at their ICU, enable the ICT and ICU staff to focus on the necessary issues and apply specific strategies for reduction of DA-HAI rates.

6. **Performance feedback**

This infection control tool is essential to enable the ICT and ICU staff to focus on the necessary strategies for improvement of low compliance rates.

Performance feedback is provided to HCWs working in the ICU by communicating the assessment of practices routinely performed by them. The resulting rates are reviewed by the ICT with ICU staff at monthly meetings, showing bar charts with compliance with infection control measures to prevent VAPs (33, 34).

Data collection and analysis

The ISOS meets the criteria set forth in the INICC protocol, which is followed by the infection control professionals (ICPs) who collect daily data on central line-associated bloodstream infections, catheter-associated urinary tract infections and VAPs, and denominator data, patient-days and specific device-days in the ICUs.

These data were uploaded to the ISOS, and were used to calculate DA-HAI rates per 1000 device-days, mortality and LOS, according to the following four formulas: 1) Device-days consisted of the total number of central line days, urinary catheter days, or mechanical ventilator (MV)-days. 2) Crude excess mortality of DA-HAI equals crude mortality of ICU patients with DA-HAI minus crude mortality of patients without DA-HAI. 3) Crude excess LOS of DA-HAI equals crude LOS of ICU patients with DA-HAI minus crude LOS of patients without DA-HAI. 4) Device utilization ratio (DURs) equals the total number of device-days divided by the total number of bed days.

Statistical methods

INICC Surveillance Online System (ISOS) version 2.0 (Buenos Aires, Argentina) was used to calculate HAI rates and DUR.

Patients' characteristics were compared using Fisher's exact test for dichotomous variables and unmatched Student's t-test for continuous variables. P-values <0.05 by two-sided tests were considered significant.

We conducted three types of analysis to evaluate the impact of our intervention on VAP rates:

First, we performed an analysis to compare the data of the first three months (baseline period) with the remaining pooled months (intervention period), using rate ratios (RR), 95% confidence interval (CI) and P value.

Second, in order to analyze progressive VAP rate reduction, we divided the data into the first three months (baseline period), followed by a period of nine months and a longer period of twelve months (intervention period). We compared the VAP rates for each follow-up period with the baseline VAP rate. We calculated the relative risk reduction (RRR) to account for the VAP rate reduction.

Third, we estimated the effect of the intervention on the VAP by means of a logistic regression model. A set of co-variables was included to account for possible interactions and confounding effects. A backward procedure that compares between nested

models using the Akaike Information Criterion (AIC) was carried out to get the final set of significant co-variables. Collinearity among independent variables was measured using the variance inflation factor (VIF). We calculated the odds ratio (OR) and 95% confidence intervals (95% CI) for the intervention and the MV-days. The effectiveness of the intervention was calculated using the formula: $(1 - OR) \times 100$, where OR is the adjusted odds ratio estimated by the model. All statistical analyses were performed using the R software version 3.2.2.

We calculated mortality rate with SPSS (version 10.0; SPSS Inc., Chicago, IL, USA).

RESULTS

During the study period, we recorded a total of 1,532 patients, hospitalized in for 9.425 days, with a total of 6,681 MV-days, at one hospital in the following two types of ICU: pediatric (800 patients) and medical/surgical (732 patients).

Patients' characteristics, such as sex, was similar during both periods, whereas age was lower during intervention. Regarding the results of the measurement of the bundle components, we registered statistically significant improvements in decreased use

TABLE 1: Patient characteristics, device use, and ventilator-associated pneumonia rates, compliance with care bundle and mortality in baseline period and intervention period

Patients' Characteristics	Baseline Period	Intervention Period	RR (95% CI)	P- Value
Study period by hospital in months, mean (range)	3	15.5 (13 - 18)	-	-
Patients, n	239	1,293	-	-
Bed days, n *	1,206	8,219	-	-
MV-days, n **	956	5,725	-	-
Age, mean SD	31.3 (28.5)	25.5 (27.6)	-	0.004
Male, n (%)	154 (64%)	772 (60%)	-	0.499
Bundle to prevent VAP				
Non-invasive ventilation, % (n/n)	17% (30/176)	27.7% (429/1551)	1.63 (1.1 - 2.4)	0.017
Performed assessments of readiness to wean, % (n/n)	5.1% (9/176)	64.7% (1004/1551)	12.7 (6.5 - 24.8)	0.001
Endotracheal cuff pressure of at least 20 cm, % (n/n)	0% (0/176)	8.6% (134/1551)	-	0.001
Absence of Condensate in ventilator circuits, % (n/n)	6.3% (11/176)	59.8% (927/1551)	9.6 (5.2 - 17.7)	0.001
Naso-tracheal intubation, % (n/n)	19.9% (35/176)	0.8% (12/1551)	0.04 (0.02 - 0.07)	0.001
Device utilization ratio: (DUR) ***	0.79	0.70	-	0.006
MV duration, mean (SD)	5.6 (6.0)	6.6 (8.2)	-	0.073
30-50 elevation of head, % (n/n)	100% (176/176)	98.7% (1531/1551)	0.98 (0.79 - 1.23)	0.908
Gastric over-distention, % (n/n)	100% (176/176)	98.3% (1524/1551)	0.98 (0.79 - 1.22)	0.8760
Subglottic suctioning, % (n/n)	100% (176/176)	91.9% (1426/1551)	0.92 (0.74 - 1.1)	0.456
Oro-tracheal intubation, % (n/n)	80.1% (141/176)	70% (1085/1551)	0.87 (0.69 - 1.10)	0.257
Invasive ventilation, % (n/n)	83% (146/176)	72.2% (1120/1551)	0.87 (0.69 - 1.10)	0.2420
Patients' mortality				
Overall mortality, % (n/n)	18.8% (45/239)	11.2% (145/1293)	0.60 (0.41 - 0.86)	0.005

CI, confidence interval; RR, rate ratio; VAP, ventilator-associated pneumonia; MV, mechanical ventilator; SD, standard deviation.

*Bed-days are the total number of days that patients are in the ICU during the selected time period.

**MV-days are the total number of days of exposure to mechanical ventilation by all of the patients in the selected population during the selected time period.

***DUR: MV-days divided by the number of bed days

of non-invasive ventilation, higher compliance on performed assessments of readiness to wean, more cases with endotracheal cuff pressure of at least 20 cm, more cases with absence of condensate in ventilator circuits, and fewer cases with nasotracheal intubation, and less MV DUR.

The levels of compliance with 30-50 degrees elevation of head, gastric over-distention, and subglottic suctioning were high at baseline and remained at the same level during the intervention period.

The percentage of overall mortality was significantly reduced at intervention (Table 1).

During the baseline period, we recorded 956 MV-days, for a mean number of days use of MV per patient of 5.6, and device utilization ratio of 0.79. There were 26 VAPs, for an overall baseline rate of 27.2 VAPs per 1000 MV-days (Table 2).

During the intervention period, during the implementation of the multidimensional infection control program, we recorded

5,725 MV-days, for a mean number of days use of MV per patient of 6.6, and device utilization ratio of 0.70.

The rate of VAPs per 1000 MV-days was reduced to 12.9 VAPs per 1000 MV-days in the second year, accounting for a 53% cumulative VAP rate reduction (Rate ratio 0.47; 95% CI 0.27 –0.81; P 0.006) (Table 2 and Figure 1).

The results of the logistic regression model are presented in Table 3. These results showed a significant reduction in the VAP risk in patients during the intervention period, when controlling for the number of MV-days and patients' ages (OR: 0.52, 95%CI: 0.31-0.89), which was associated with the implementation of the IMA. The model also showed that the intervention was not sensitive to the amount of time since the intervention was implemented, which may indicate that the INICC method was rapidly understood by the health staff responsible for its implementation. The model also detected a significant excess risk for a unit increase in the MV (OR:

TABLE 2: Ventilator-associated pneumonia rates stratified by length of participation of each intensive care unit.

Months since joining INICC	Nº of ICUs	MV days	VAP	Crude VAP rate/1000 MV days (IR)	RR (95%CI)	RRR (%)	P- Value
1-3 months (baseline)	2	956	26	27.2	-	-	-
4-12 months	2	3,652	73	20.1	0.74 (0.47 – 1.2)	26%	0.192
13-24 months	2	2,100	27	12.9	0.47 (0.27 – 0.81)	53%	0.006

INICC, International Nosocomial Infection Control Consortium; ICUs, intensive care units; VAP, ventilator-associated pneumonia; MV, mechanical ventilator; IR, incidence-rate; RR, rate ratio; RRR, relative risk reduction.

FIGURE 1: Ventilator-Associated Pneumonia Infection Rates Reduction by length of participation of each intensive care unit

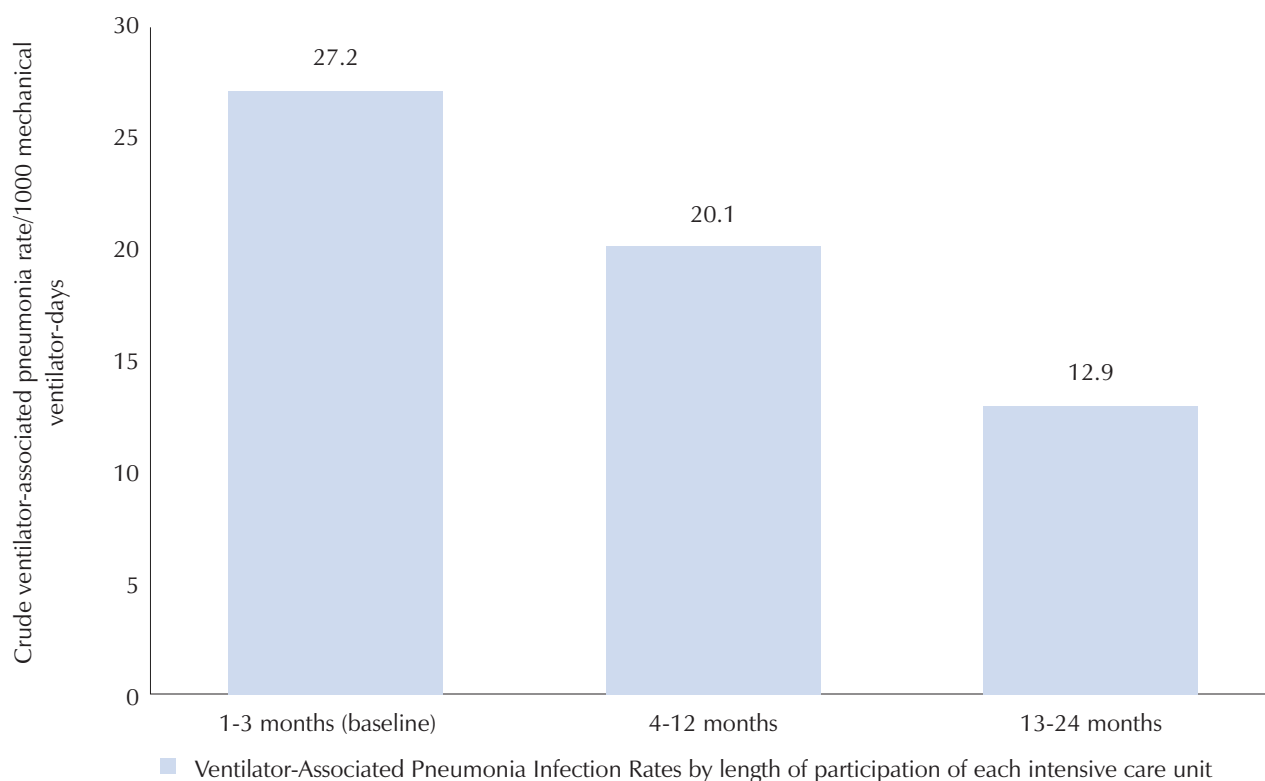


TABLE 3: Results of the logistic regression model showing the effect of the INICC intervention on the ventilator-associated pneumonia rate.

Variables	Crude OR* (95% CI)	Adjusted OR** (95% CI)	P-value
Period (intervention)	0.72 (0.45-1.15)	0.52 (0.31-0.89)	0.01
MV-days***	1.15 (1.12-1.19)****	1.16 (1.14-1.18)****	0.00
Age	1.01 (1.00-1.02)****	1.01 (1.00-1.02)****	0.01

CI, confidence interval; OR, odds ratio; VAP, ventilator-associated pneumonia; MV, mechanical ventilator.

* Bivariate analysis.

** Logistic regression model including the 3 variables in the table.

***MV-days: the total number of days of exposure to mechanical ventilation by all of the patients in the selected population during the selected time period.

****For a unit increase in the MV-days or the age of patients.

1.16, 95% CI: 1.14-1.18). The adjusted effectiveness of the intervention was 48% (95% CI: 11-69%). There was no significant interaction detected between the intervention and the MV-days. Collinearity indices in the final model were low (1.015–1.035), indicating absence of multicollinearity among the independent variables.

The predominant microorganisms during the baseline period were *Pseudomonas aeruginosa*, *Candida albicans* and *Staphylococcus aureus*, while during the intervention period they were *Pseudomonas aeruginosa*, *Acinetobacter baumannii* and *Klebsiella pneumoniae*.

DISCUSSION

This study was conducted with the aim of assessing the effect of a multidimensional approach infection control approach in the ICU setting from Malaysia. The comparison of the baseline rate of VAP found in this study (27.1 per 1000 MV-days) shows that it was almost ten-fold higher than the US 0.8 VAP rate per 1000 MV-days determined by the CDC/NHSN for 2013 (35);(35) and similar to the 6.8 rate determined by the German “Krankenhaus Infektions Surveillance System” (KISS) (36). In comparison with VAP rates from other developing countries, our VAP baseline rate was higher than the last international INICC report for 2007-2012 (7.9 VAPs per 1000 MV-days [CI, 7.4 – 8.4]) (17). Within the scope of studies addressing the burden of VAPs in Malaysia, study conducted by Gopal Katherason et al. in 4 ICUs found that the device-related VAP infection rate was 27.0 % (n = 58), with a MV DUR of 88.7% (12).

In our study, the high VAP rate at baseline was reduced from 27.2 to 12.9 per 1000 MV-days (rate ratio 0.47; 95% CI 0.27 – 0.81; P 0.006), showing a 53% VAP rate reduction. This reduction can be associated with the implementation of the IMA, as most of the bundle components showed statistically significant improvements.

The percentage of overall mortality was significantly reduced at intervention. As shown in previous studies performed by the INICC, implementation of a four or six-component multidimensional approach for VAP resulted in significant reductions in rates of VAP in limited-resource countries (18, 25-28). In the pooled VAP rates of pediatric ICUs of 4 developing countries the implementation of the IMA was associated with 31% VAP rate reduction (11.7 vs. 8.1 VAPs per 1000 MV-days) (29); in neonatal ICUs of 10 countries, it was

associated with a 33% VAP rate reduction (17.8 vs. 12.0 VAPs per 1000 MV-days) (30); and in adult ICUs of 14 countries, it was associated with a 55.83 % VAP rate reduction (22.0 vs. 17.2 VAPs per 1000 MV-days) (31).

Study limitations

The main limitation of this study is that it is a single-center study. However, in this study it was proved that a multidimensional approach is fundamental to fight against the incidence of VAPs and mortality in the ICU setting.

Second, the three-month baseline period may be short and might have overestimated the effect of the intervention. Third, there may be significant variations in the level of quality control in the laboratories that support each individual hospital and we could not quantify in detail all the interventions included in our multidimensional approach, such as education and compliance with hand hygiene practice.

CONCLUSIONS

This is the first study to report a substantial reduction in VAP rates and mortality in the ICU setting of Malaysia. The implementation of our multidimensional approach was associated with significant reductions in the VAP incidence rate and mortality rate. These systematically collected data serve as guidance for strategies to improve patient care practices, as demonstrated in several studies conducted in limited-resource countries. These preventive strategies demonstrated effective in the INICC ICUs of Malaysia can promote a wider acceptance of infection control programs in hospitals, leading to significant VAP rate and mortality reduction worldwide.

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Healthcare workers' awareness and perception of infection prevention and control policies and practices amidst viral haemorrhagic fever epidemics in Nigeria: A qualitative study

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ABSTRACT

Background: Hospital Acquired Infections (HAIs) are a major cause of morbidity and mortality in Nigeria, although one-third of them can be prevented through standard infection prevention and control programs (IPAC). Recent healthcare crisis with Ebola virus disease highlighted the need for robust IPAC programs in Nigeria. This study assessed healthcare workers' awareness and perception of IPAC policies and practices.

Methods: This was a qualitative, cross-sectional, descriptive study in which two secondary-level and one tertiary hospital were selected by simple random sampling. Research instrument was a standardized focus group discussion guide analyzed using the NUDIST version 6.0.

Results: There is a wide knowledge and awareness gap with regards to Universal Precautions/Routine Practices and other infection control practices among healthcare workers (HCWs) studied. Infection control practices are still inadequate among the HCWs but poorer in the secondary level facility. Institutional policies on infection control, though existent, are weak and uncoordinated.

Conclusion: The existing infection control policies should be strengthened to protect health care workers and patients from hospital acquired infections. Infection control policies should be established where there are presently none.

KEY WORDS:

Infection control policies, occupational injuries, healthcare workers

INTRODUCTION

Hospital Acquired Infections (HAIs) are a major constraint to effective provision of healthcare services globally. HAIs constitute considerable occupational hazard to the limited health workforce in resource-poor countries and are a significant contributor to morbidity and mortality among health workers and patients (1,2).

Hand hygiene (HH) is one of the commonly recommended strategies for effective control of HAIs (3). Hand hygiene is a simple and cost-effective way to disrupt the transmission of infectious agents contracted via contact with blood, other body fluid or contaminated surfaces (4-7). However, in resource-poor countries such as Nigeria, adherence to recommended practices remains a challenge (8). Recent healthcare crisis with Ebola virus

disease (EVD) has further highlighted these challenges. Earlier studies have shown that health facilities often lack adequate supply of basic infrastructure such as running water, detergents, alcohol rub, personal protective equipment, appropriate colour-coded storage or waste disposal bags or containers (8-12). Furthermore, the level of the workload has been linked to forgetfulness in carrying out basic infection control practices such as handwashing before and after every patient contact (8). Each new case of EVD and the ongoing Lassa fever epidemic, was exponentially increasing the workload for healthcare providers.

These recent outbreaks in which deaths were recorded within the health workforce in Nigeria underscored the urgency to review the basic infection prevention and control strategies in the country's healthcare system (13,14). This study aims

Conflicts of interest

No author has any conflicts of interest

Funding

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to qualitatively assess healthcare workers' awareness and perception of policies and practices with regard to hospital infection prevention and control, and management of occupational injuries in Ibadan province of Nigeria.

METHODS

Study design and setting

This was a qualitative, cross-sectional, descriptive study carried out among health care workers in the government-owned hospitals within Ibadan, Oyo-state Capital, southwestern Nigeria. There are three state hospitals (secondary/community) and one federal (tertiary/teaching) hospital in the city.

Ethics and study population

Ethical clearance was obtained from Oyo State Ministry of Health ethical review committee. Study participants included physicians, surgeons, nursing staff, auxiliary staff, and hospital administrators.

Data collection

A total of 20 focus group discussions (FGDs) and 40 in-depth-interviews (IDIs) were conducted proportionate to the size of the workforce in each participating hospital.

The FGDs were conducted by the principal investigator using an instrument developed based on the study objectives and review of relevant literature on the topic. Both the FGD and the IDI were used to explore participants' perception about and understanding of infection control practices and policies. The same instrument was used for both the FGD and the IDI. A FGD consisted of groups of 10-12 people, while an IDI session involved a one-to-one interaction between the investigator and a principal person.

Data analysis

Data were transcribed, translated and entered into Microsoft Word and converted to text files for analysis. Analysis was done using the NUDIST 2.0 program. The data analysis was conducted on a question-by-question basis. Transcriptions of interview materials occurred immediately following interview completion.

RESULTS

Awareness of HCWs

Healthcare workers (HCWs) in both the secondary and the tertiary level hospitals generally had a high level of awareness of Universal Precautions/Routine Practices (UP/RP). The reported sources of information among HCWs of tertiary hospitals were workshops/seminars, hospital guidelines as well as professional groups. In contrast, the main source of information among HCWs in secondary hospitals was the instruction from senior colleagues on the observation of Universal Precautions/Routine Practices.

Data from both FGDs and IDIs in secondary facilities revealed that HCWs were less informed about collection, reporting and dissemination of information on HAIs. According to the HCWs, infection control committees did not exist in the

secondary hospitals. According to one HCW: *"There is no infection control committee here; individual HCWs monitor themselves."*

Only HCWs in the tertiary facility reported in-service training, lectures, seminars, health education workshops and posters as a form of reminders to observe UP/RP at the workplace. However, the hospital management did not take active role in these activities. Participants from the secondary facility reported that the common form of training for the HCWs was senior employees instructing their junior colleagues in sharps injury prevention and basic infection control.

Availability of health and safety policies was a poor predictor of HCWs' awareness of the policy's existence. In the tertiary facility where such policies were developed many of the HCWs were not aware of them. In a FGD in the tertiary facility, one of the resident doctors reported as follows: *"There is a UCH (hospital) policy, and in fact they have a committee on infectious disease control but the problem we have is that most are not aware of the existence of this committee and also, what they are supposed to do."*

There was no system of data collection, reporting or dissemination on hospital infection control practices in secondary facility.

Infection control practices among healthcare workers

Infection control committee

Infection control practices were reported to be fairly effective in the tertiary facility. However, one of the IDI participants said the practice in the tertiary facility was not adequate as a nurse rather than an epidemiologist serves as the infection control officer. In the tertiary facility, challenges about infection control are reported to the infection control officer. There was also an infection control committee, which meets regularly.

One head of department in the tertiary facility was visibly angry when he said: *"You see, this hospital is just too big, though there is a written policy about infection control and the committee meets anyhow, the effect of their meetings is hardly felt. I can't really blame them, the resources to work with are just not enough; talk about water, disinfectants, electricity to sterilize, the number of people to clear the rubbish and so on and so forth, the list is endless."*

Use of personal protective equipment (PPEs)

The use of personal protective equipment and hand hygiene is not strictly adhered to in all three centers. Use of PPE, in particular, was largely limited to nursing staff.

Not all HCWs complied with proper PPE protocols, partly due to unavailability of equipment and partly due to poor compliance with proper donning/doffing techniques, even when PPE was available. Short supply was another factor militating against the use of PPE in all three hospitals, as provision of these is grossly inadequate and often rationed.

Environmental cleaning and disinfection

In all three centres, HCWs reported regular cleaning/disinfection activities, including sweeping, scrubbing and fumigation of the OR and wards. Fumigation using formaldehyde is a common infection prevention practice in Nigeria for heavily contaminated hospital surfaces.

Infection control surveillance

HCWs in the secondary facility reported that there was no structured infection control surveillance in place. In all three centres, collection of data on hospital-acquired infections was inadequate. In the tertiary facility, it is neither routine nor well established. In a FGD, one of the doctors said: *“Hospital infection control in UCH I think is a bad job, because people seem not to be aware of measures that are put in place to limit the spread of infection or they just go out of their way to disregard the rules totally.”*

In the tertiary facility it was mentioned that, reporting and subsequent isolation of organisms led to the closing down of neonatal ward and some of the ORs. In the secondary facility, HCWs generally believed that nosocomial infection never happened in their setting. According to a physician from the secondary facility: *“None that I know of, at least none since I came more than four years ago.”*

Disposal of sharps

The practice of using sharps containers only existed in the tertiary facility, although the number of containers was inadequate, with a single bin serving several rooms. Thus some of the HCWs still dropped their used sharps into regular garbage bins. Recapping of needles is still a common practice among HCWs. A doctor from a FGD in the tertiary facility reported of the dangers faced by the cleaners especially: *“You throw your used needles into the ordinary bin, the cleaner comes in and empties it. The needle fall, she goes on with her glove in hand to pack the needles from the floor and throw them into the bin.”*

Factors against infection prevention and control

Healthcare workers in all centres mentioned financial constraints as the most important limiting factor for the practice of UP/RP, since it affects the purchase of adequate quantity of PPE and also negatively affects the proper management of injuries from needles and other sharp objects. Some of the materials mentioned to be in short supply include disinfectants, soap, chemicals for washing linen, gloves, facemasks, boots, surgical gowns etc.

At the secondary facility, a Consultant-in-Charge pleading anonymity said during a IDI: *“We know what to do to prevent infection in the hospital, but there is a difference between knowing what to do and actually doing it. For example, there is no proper waste disposal system here, we do not have an incinerator to burn our waste properly the way it should be done. What we do is dig out a shallow pit and bury both sharps and the non-sharp materials just outside the main hospital premises, and cover it up with soil. Everybody knows this is not appropriate but what can you do when the administrators in the ministry (of health) did not see the importance of funding the hospital properly, sometimes the buried waste gets exposed especially after a heavy rain washes the top soil away, you can imagine the danger this could pose to the HCWs and the people that live nearby.”*

Communication gap is another factor affecting an effective hospital infection control as hospital policy in the management of infections and injuries from sharps is not well circulated and does not get to the HCWs.

A staff nurse in the tertiary facility during a FGD said: *“The result of their meeting usually comes in form of a paper, the print-out is poor, it is not interesting to read, and very difficult to understand.”*

Poor political will on the part of the hospital management board especially in the secondary facility were mentioned as an important limiting factor against an appropriate hospital infection control. A senior administrator in the secondary facility said: *“Please don’t quote me, but this hospital is poorly funded, and we cannot say anything on our own to change the situation, we have to make use of what we have, just managing below standard, or what can we do?”*

DISCUSSION

Major factors hindering hospital infection control in the hospitals include poor infrastructure and resources, poor funding of infection prevention and control activities, and poor compliance of HCWs with UP/RP.

Findings from both the in-depth interviews and the focus group discussions showed a high level of awareness about UP/RP among HCWs in both hospital groups, which was supported in a previous study (15). However, awareness alone does not lead to adoption of an expected behaviour (9,16). In this study, though the participants’ level of awareness on UP/RP was good, it was at odds with their practice.

Absent hospital infection control policies and committees is a widespread problem in the Nigerian healthcare system, and is generally below 40% (8,17,18). Non-compliance with the use of PPE has been reported elsewhere as resulting from inadequate availability and/or poor attitude of HCWs to using them even when they are available (9,19-21).

Poor infection control infrastructure, inadequate supplies, limited access to potable water, shortage of waste disposal containers have been reported in other studies as factors militating against infection control practice in developing countries (21,22). At least partly, this could also be due to communication gap between the hospital administration and the HCWs, which contributes to an environment where incidents of unprotected exposure to HAIs are systematically downplayed. An effective communication channel between HCWs and hospital management is important in the steady supply of equipment required for infection control.

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Improving hand hygiene compliance by changing safety culture in an academic medical center

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ABSTRACT

Background: Healthcare-associated infections are often transmitted by the contaminated hands of healthcare workers. When non-conformance to hand hygiene practices are unaddressed, patient safety is at risk. Many characteristics of academic medical centers (AMCs) contribute to the reluctance of staff to speak up. The aim of this project was to improve hand hygiene compliance by transforming the culture at an AMC.

Methods: This project involved staff and leaders from multiple disciplines and various levels within the University of Texas Southwestern Medical Center (UT Southwestern). Neutralizing steep authority gradients, organizational influences, and environmental factors encountered in an AMC was accomplished using the Plan-Do-Study-Act (PDSA) method of quality improvement, applying appropriate quality improvement tools to uncover underlying causes and factors that contribute non-conformance, and garnering the active support of the most senior organizational leaders.

Results: Beginning on September 2011, the project achieved a combined system-wide average compliance rate of >95% and sustained it for 23 consecutive months as reported from data collected by infection prevention and control (IPC) "secret shoppers."

Conclusion: This project empowered more members of the health care team to speak up which contributed significantly to increased compliance and transformed the organizational culture around hand hygiene.

KEY WORDS:

quality improvement, safety culture, hand hygiene, patient safety, authority gradient, academic medical center

INTRODUCTION

UT Southwestern is an academic medical center comprised of two acute care teaching hospitals located in Dallas Texas. These hospitals are St. Paul University Hospital, a 300-bed acute care hospital with medical surgical units, medical surgical intensive care units (ICUs), and cardiovascular ICU, and Zale Lipshy University Hospital, a 152-bed acute care hospital with neuro/neurosurgery units, urology units, and neuro/surgical ICU, psychiatric, and rehabilitation units. These hospital structures were built between 25-50 years ago respectively. In December 2014, the William P. Clements University Hospital opened, replacing St. Paul Hospital, which was decommissioned shortly afterwards. UT Southwestern cares for more than 100,000 hospitalized patients annually.

The UT Southwestern University Hospital hand hygiene compliance ranged from 80% to 92% during the baseline years 2009 through 2010 with a mean of about 88% despite educational interventions. These were based on direct observation. The authors do acknowledge the many drawbacks to the direct observation method including the questionable inter-rater reliability of the observers, the amount of time required to complete the observations as being onerous, and the likeliness that observed staff members change behavior when they know they are being observed which can falsely elevate the

compliance rates [1-5]. The Hawthorne effect proved beneficial in this project, and the team capitalized on behaviour change under observation to help accelerate the transformation of the existing culture [6].

Improving the environmental factors associated with aging facilities was challenging. Several environmental factors related to supplies, equipment, and layout of patient care areas contributed to unsafe hand hygiene practices. Even more challenging was the staff perception that it was unsafe to speak up and hold others accountable due to the different power gradients encountered across disciplines at an academic medical center. We encountered supervisory issues in which staff from various disciplines violated existing rules with no resulting corrective action. We had no means to measure our results against interventions and could not demonstrate whether any changes we made resulted in improvements.

The IPC department monitors hand hygiene compliance by using trained observers, or "secret shoppers," who perform at least 30 observations per unit each month system-wide. Secret shoppers consisted of clinical staff (nurses, patient care technicians, ancillary team members) and non-clinical staff (administrative assistants, analysts, non-clinical managers and other support staff). Hand hygiene in-services, traditional compliance campaigns, and track-and-trend activities with

compliance reports sent to the unit managers were ineffective in improving and sustaining compliance rates across the institution.

The relationships among nurses, allied health providers, residents, support staff, medical students, fellows, and attending physicians are complex [7-15]. The characteristics typical of an AMC such as set hierarchies within the medical and nursing staff, makes it difficult for those with less power to speak up [7, 16-19]. National survey results showed that the staff nurses at this medical center were very satisfied with the degree of collegiality they experienced with physicians. However, nurses and support staff were reluctant to speak up whenever they observed non-conforming behavior related to hand hygiene by members of the medical staff at all levels. When communication is inhibited, it becomes more difficult to address problems holistically [11, 16].

METHODS

The project team approached this problem using quality improvement tools and principles, and several small tests of change in PDSA cycles following the purpose and context of the project in pilot units.

The team used brainstorming techniques in focus groups consisting of nurses, technicians, transporters, and other support staff to gain better understanding of the causes behind the resistance to speak up. The concept of authority gradient was introduced to healthcare in the Institute of Medicine's report, *To Err is Human* [20]. Power hierarchies or "authority gradients" emerged as a major contributor. In addition, it was clear that there was a high degree of personal risk perceived by staff at the lower end of the power hierarchy if they were to speak up when they observed incidence of non-conformance to proper hand hygiene. Some of the fears described included worry about ridicule, apprehension regarding retaliation, and fear of ostracism. Many of those involved expressed that "it was just easier to go along with the others than it was to speak up."

The World Health Organization considers unobtrusive direct observation of hand hygiene practices by trained observers a the gold standard for evaluating compliance [21]. Hand hygiene compliance rates at UTSW University Hospitals are derived by the observations submitted by secret shoppers. The Director for IPC instructed each secret shopper to observe and document proper hand hygiene practices as defined by hospital policy. The IPC department regularly recruits, trains, and rotates secret shoppers throughout the health system to help maintain anonymity. The secret shoppers must submit at least 30 observations for each clinic or patient care unit per month. If fewer than 30 observations are documented, the unit is excluded from the monthly reporting period. Secret shoppers do not perform observations on their home units.

The Hand Hygiene Project Team included staff nurses, nursing managers, physician advisor, infection prevention practitioner, administrative associate, and a nursing director. The team reviewed the current literature and standards from the Centers for Disease Control and Prevention (CDC) [22] and from the World Health Organization (WHO) [23] to define best practices based on the best available evidence.

The IPC Department used information from the secret shopper observations, (observed compliance/opportunities for hand hygiene compliance), and generated monthly hand hygiene percent compliance reports sorted by patient care unit. The IPC department shared these reports with various groups including the Infection Control Committee, managers, and directors of nursing units, Process Improvement Committee, and distributed them electronically to department managers for posting on the patient care units.

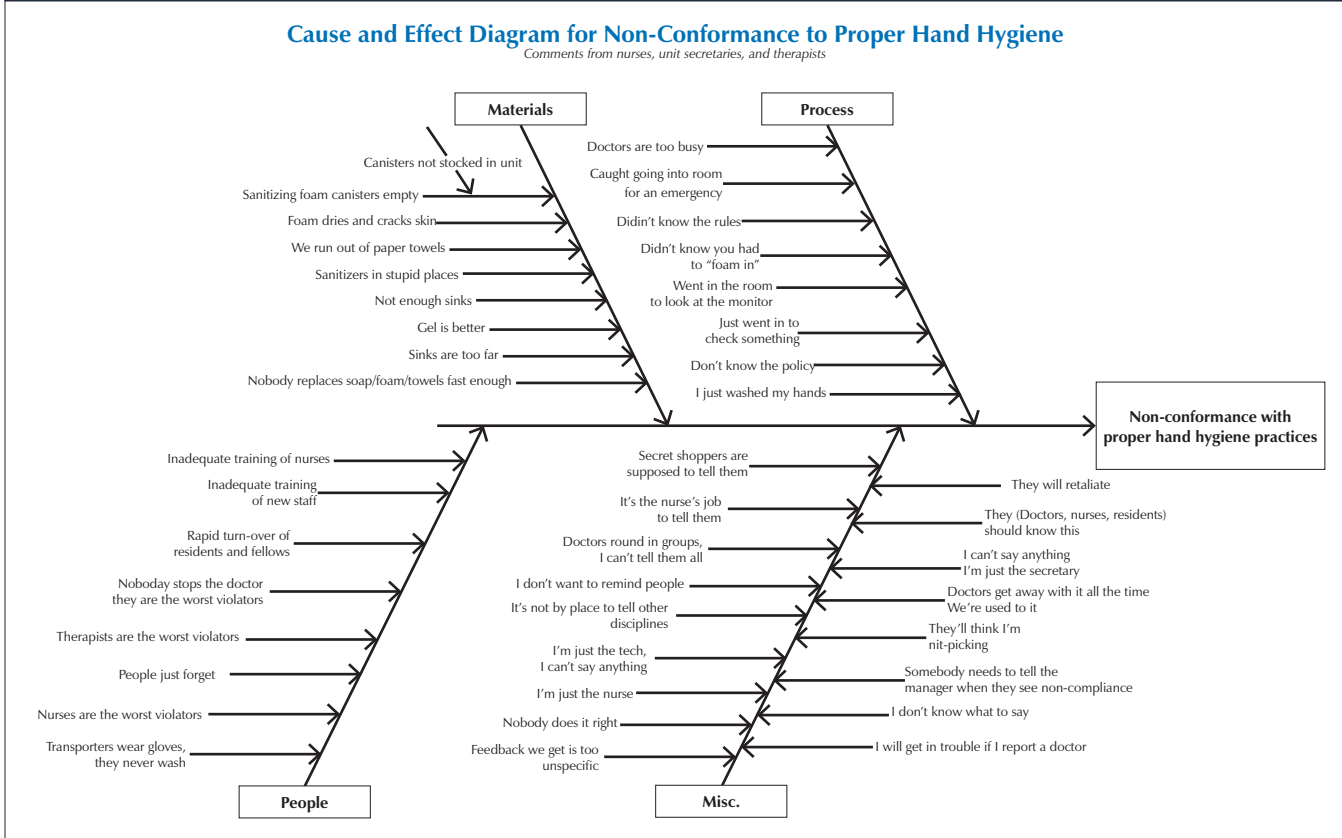
Baseline compliance rates for hand hygiene consisted of the 24-month period from January 2009 through December 2010 (Figure 3). These rates were plotted using statistical process control charts. Control charts were used as analysis tools to assist the team with monitoring the stability of the hand hygiene processes in this project. Prior to this project control chart were not used to analyze compliance. Variations were noted in the baseline data, but special causes were undetermined.

The results of the UT Southwestern 2010 NDNQI® (National Database for Nursing Quality Indicators), show that the Collegial Nurse-Physician Relations sections were remarkably favorable and better than the national mean for academic medical centers, suggesting that the staff nurses at this medical center were very satisfied with the degree of collegiality they experienced with physicians. The project team conducted several focus meetings that included brainstorming sessions. Representatives from three adult intensive care units (ICUs), cardiac catheterization lab, telemetry units, and non-ICU units on the St. Paul campus volunteered to collect and summarize data from front-line staff about the factors thought to contribute to non-conformance to proper hand hygiene practices and constructed a cause and effect diagram (Figure 1).

In these sessions, many staff members expressed that they were on the low end of the authority gradient and perceived high degree of personal risk whenever asked to speak up to remind a physician about hand hygiene when nonconformance was noted. The same reluctance to confront non-conformers was noted for non-nursing staff confronting a nurse. This perception was expressed verbally and non-verbally during the brainstorming exercise, and was noted in the cause and effect diagram "miscellaneous" section (Figure 1). Staff members in the participating units were asked to rank themselves in the healthcare hierarchy. Not surprisingly, the majority of the staff, including nurses, perceives themselves to be lower than physicians, fellows, and residents in the healthcare hierarchy.

Expressing concern, questioning, or simply clarifying instructions was found to require considerable determination on the part of nurses, clerks, or patient care technicians who recognize their input as devalued or bluntly unwelcome by physicians or other providers. Staff repeatedly communicated to the project team that they experienced even more uneasiness, hesitation, stress, or anxiety when asked to speak up and hold all staff accountable for proper hand hygiene.

FIGURE 1: Cause and effect (Ishikawa) diagram summarizing the perceived causes that contribute to non-conformance to proper hand hygiene. The participants in these focus groups were frontline patient care technicians, nurses, unit clerks, and respiratory therapists.



Interventions

Pilot: Feb.-Apr. 2011

Our pilot included eight patient care areas: The Cardiovascular Intensive Care Unit (CVICU), the Medical and Medical/Surgical ICUs (MICU, 7W ICU), the Cardiac Catheterization and Interventional Radiology labs, step-down cardiology, medical/surgical telemetry, post-interventional unit, and dialysis unit. We reviewed literature related to authority gradients in aviation [24-33], and the CDC [22, 34] and WHO [23] literature describing safe hand hygiene practices. A short checklist that contained the key elements of hand hygiene was developed. Since unit managers were thought to be less threatened by power gradients than staff, the managers of the pilot units and four clinical coordinators were coached and educated to be the trained observers and use the observation tool. The managers were instructed to observe and document at least 10 hand hygiene opportunities daily in each of their respective areas of responsibility for at least five days every week for three months. The project team anticipated that the behaviour of the observed staff would change, and used the Hawthorne effect to help drive and accelerate the culture change. Managers would positively reinforce conformance with proper hand hygiene practices by verbal and appropriate written affirmation, and by distributing tokens to conforming individuals such as buttons and badges that demonstrated patient advocacy and patient safety championing.

Given that communicating observed non-conformance in individuals from the various disciplines and with senior physicians would be awkward for all involved, the project team coached and supported the managers in the pilot units carefully [15, 35, 36].

We completed and tested the observation tool, tested the "Duty to Follow a Procedural Rule" checklist with talking points to standardize how the managers addressed failures with the underlying premise that managers set the climate of their areas, and when violations are permitted to continue, leniency to failures and violations becomes the cultural norm [37-39]. The managers in pilot unit presented the project to the Patient Care Managers and Directors team, which consisted of multidisciplinary directors and managers. Our CQO presented the project to the senior (physician) faculty and department chairs. The project team worked very closely with the Executive Vice President of Health System Affairs, Chief Nursing Officer, Chief Quality Officer, Chief Medical Officer, Chief Executive Officer for the University Hospitals, and the medical directors of the pilot units prior to implementing the pilot. This was necessary in order to establish support from the most influential leaders in the organization and to inform various groups of professionals that non-conformance would be addressed immediately by the unit manager. The CMO sent communication to all healthcare system staff giving a brief

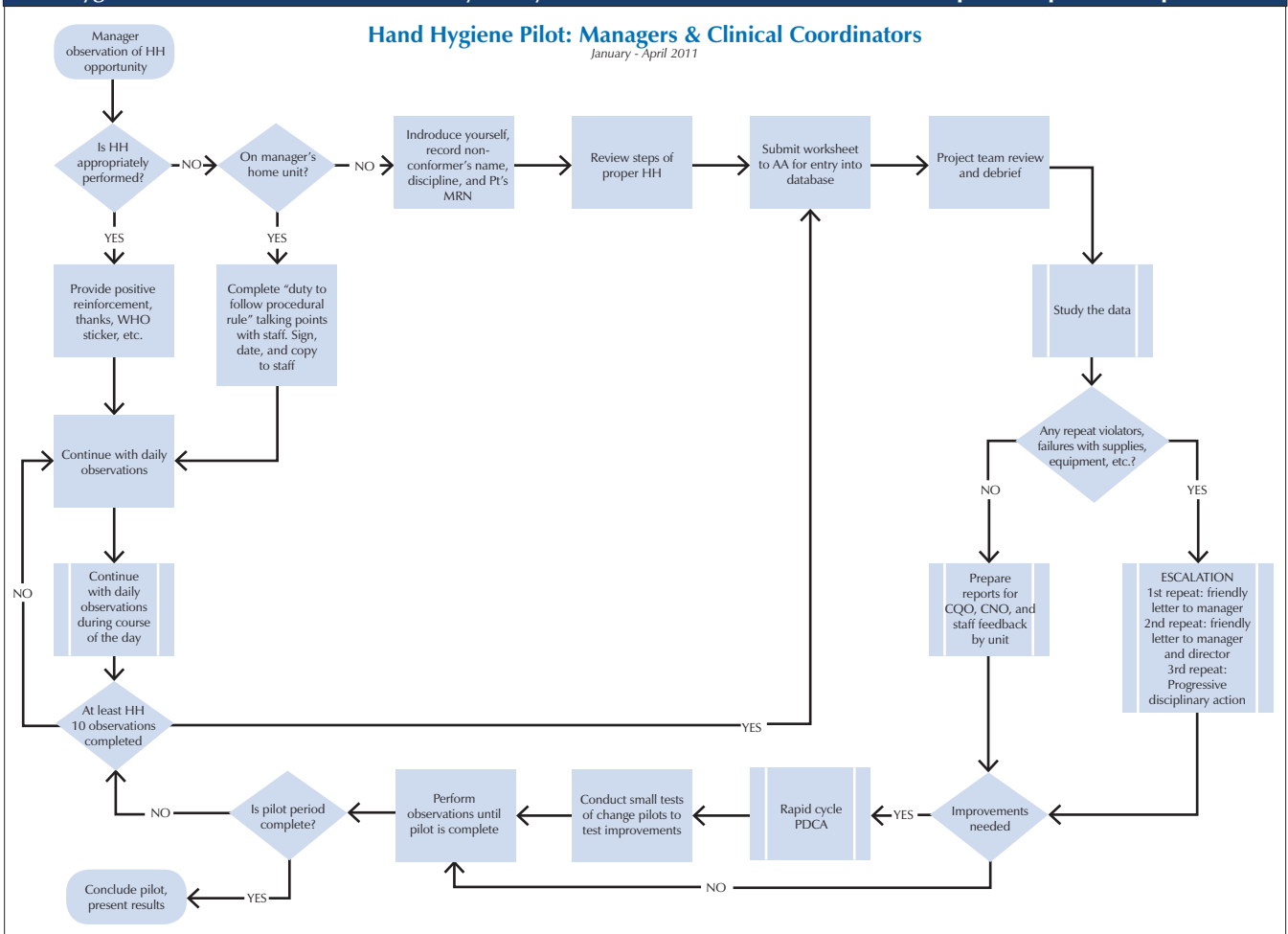
overview, statement of support endorsing the project, and asked medical staff to not “shoot the messenger” should the occasion arise that anyone mentioned any observed non-conformance to proper hand hygiene. The project team created a process of accountability and escalation for the pilot (Figure 2), and developed a database of all non-conforming individuals. This database included pilot week number, the unit where non-conformance occurred, the name and discipline of the non-conforming individual, a notes section, and dates.

Next letters were sent to the person’s supervisor for repeat offenders. In the case of physicians, residents, and fellows, the various department chairs and division chiefs were notified of nonconforming physicians and copied on all correspondence from the unit manager to the nonconforming individual. The database allowed the project team to keep track of non-conforming individuals who practiced risky behavior in several units, and manage accountability and escalation as needed. At first, physicians, residents, and fellows did not take the manager letters seriously and expressed mild annoyance or offense toward the unit manager. Attitudes and behavior changed

when the nonconforming individual was confronted by medical directors and physician leaders regarding the observations. Although the prospect of addressing physician non-conformance was daunting, unit managers reported no perceived or open retaliation directed at them or towards other staff members after physician leaders followed up with nonconforming physicians in support of promoting patient safety.

By week three, the managers became more comfortable with speaking up, and expressed less concern with criticism directed personally at them whenever they observed nonconformance. They continued daily monitoring, addressing nonconformance and performed just in time teaching. They sent non-punitive letters of caution to the supervisors, department chairs, medical directors, and managers of repeat violators from other units or services with the date(s) and the units in which they did not perform proper hand hygiene. The managers also noted in the letters that they addressed the violator’s failure, and provided the violator with just in time teaching on proper hand hygiene techniques prior to sending the letter. Managers taught their respective staff effective and

FIGURE 2: Process map showing the steps involved in the pilot process for nursing unit managers and their designees for daily hand hygiene observations. Observers for the pilot project were not the same individuals that served as “secret shoppers” who were trained by the IPC Department. The managers in the pilot units were instructed to observe at least ten opportunities for hand hygiene in their areas for at least five days every week for three months and follow the steps in the process map.



non-confrontational communication so that they had the tools to speak up more confidently.

Some staff members expressed that they were still not comfortable with speaking up. The managers distributed metal clicker noisemakers to the staff, and instructed them to use the clickers whenever they observed anyone anywhere in their units who did not perform correct hand hygiene. This enabled the staff to call attention to nonconformance without direct confrontation. The clickers were initially used frequently. The noise served to start the conversation in units about hand hygiene and alert everyone that someone somewhere in the unit did not perform hand hygiene correctly. Some staff felt uncomfortable using the clickers towards the end of the pilot, because they felt that clickers had negative associations with dog training. The project team left it up to the discretion of the staff whether to use the clickers or not. A few units, such as the Cardiovascular ICU used the clickers beyond the pilot phase. Managers in the pilot units reported to the project team that some residents and fellows requested clickers and used them as well. The managers who sent caution letters to the supervisors of the repeat violators received supportive responses. Medical directors were particularly supportive, and their feedback was reported back to all staff, which served to encourage those at the front line, and further level the power gradient.

The equipment/supplies issues that staff brought forward in the fishbone diagram were resolved through collaborating with the IPC department, Materials Management, and Facilities departments. The project team highlighted the removal of those barriers to staff, and emphasized that resolving the issues they brought forward made it easier to perform proper hand hygiene.

Spreading and sustaining

At the end of the three-month pilot, the Chief Nursing Officer endorsed the spread of the pilot to all patient care units and procedural areas in both hospitals. Early in the fourth quarter of project year one, a staff-led Hand Hygiene Committee was formed, and “Speak Up for Hand Hygiene” was the theme. The Chief Medical Officer and Infectious Disease physician leaders conducted Infection Control Town Hall meetings, and highlighted the importance of hand hygiene and patient advocacy, committee endorsement, and overall project support, which served to strengthening the force driving the climate shift towards a patient safety culture.

By the start of project year two, Hand Hygiene Committee members routinely performed observations in “non-home units.” The original project team had transitioned the project to the committee and the IPC department. Although daily observations, just in time teaching, and escalation processes continued, no self-reported data were sent to the IPC department. The secret shoppers continued with their assigned duties as directed by IPC. Managers who were involved in the pilot shared their experiences at committee meetings, which helped set the tone for the other managers to conduct hand hygiene rounds on their own units in addition to the activities in progress led by the Hand Hygiene Committee and IPC secret shoppers. The original database and manager-to manager letters for repeat violations was eventually retired, as secret shopper-

reported observations showed sustained improvement in university hospitals, clinics, and procedural areas.

RESULTS

System-wide hand hygiene compliance as reported by the IPC department achieved 95% by the end of the third quarter of project year one. These secret shoppers must report a minimum of 30 observations per unit per month. Average hand hygiene compliance achieved and sustained 95% compliance for 22 months from September 2011 through July 2013 (Figure 3).

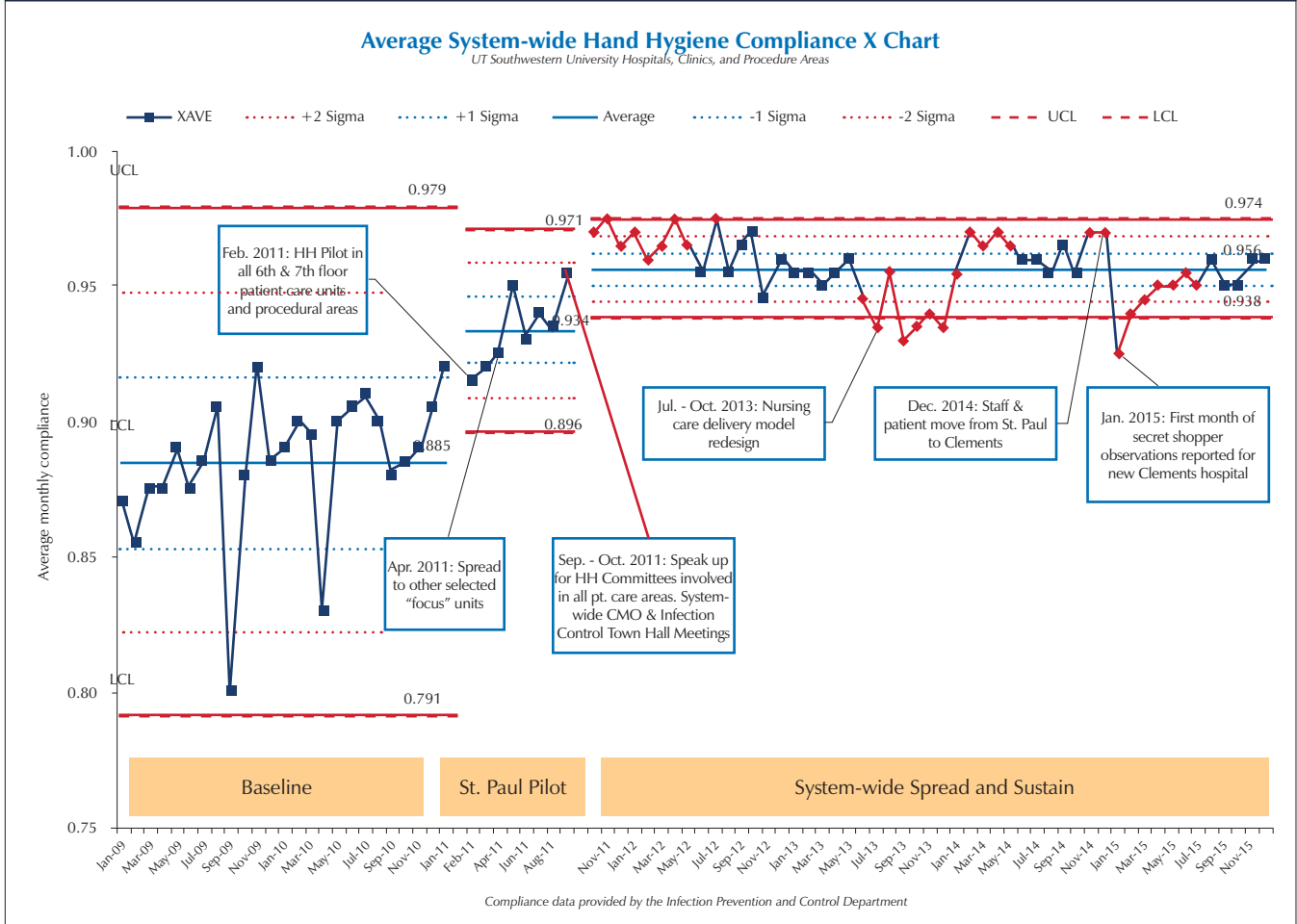
DISCUSSION

We must reiterate the limitations of direct observation. Although the IPC department was not part of the project, nor serve as active participants in the project per se until project handover in year two, the spread and sustain phase. The role of IPC department, their processes, and leadership remained constant pre and post project interventions. The IPC director was responsible for recruiting and training all secret shoppers prior to the start of the project and continued throughout the project-reporting period. The IPC department maintained oversight and assurance of inter-rater reliability of the observers, and monitored time required to complete the observations. The secret shoppers did not directly confront nonconforming individuals. Their processes, as stated earlier, did not change throughout the duration of the project-reporting period.

Using QI tools such as run and control charts serve as excellent tools to provide feedback to all stakeholders. QI methodologies to standardize processes and assess the stability of these processes helped to reduce hasty or reactive implementations of new interventions in response to variations in hand hygiene compliance. Analysis of human factors, environmental factors, and organizational influences helped to reveal the underlying reasons for failures. Improving the availability of hand hygiene supplies, abundant and prominently displayed of foam dispensers (and the number and placement of sinks in Clements), addressed environmental factors, making it easy to conform [40].

In July through August 2013, the care delivery model was redesigned for nursing in both Zale Lipshy and St. Paul hospitals at UT Southwestern. Leadership changes and nursing staff turnover left gaps in the frontline staff as many front line nurses were promoted. The newly promoted nurses became very involved with learning new responsibilities and skills associated with their new roles. One of the downstream effects was that agency and “float” nurses filled bedside positions left vacant by the promotions of some of the front-line nurses. Secret shoppers did not change their observation processes and continued with observations and reporting. Although overall average compliance dropped, it never fell below 90%, and no new interventions were introduced. By January 2014, average overall compliance was back up to 95.9%, and stayed above 95% for 12 consecutive months. The in-patient move to the new university hospital was disruptive and compliance dipped bringing the overall compliance to 92.5% at Clements, while overall average compliance at Zale Lipshy inpatient units and procedural

FIGURE 3: Annotated control chart depicting hand hygiene compliance over seven years.
 Observations were reported by secret shoppers who were recruited and trained by the IPC Department.
 Secret shoppers reported on 30 observations in all patient care and procedural areas monthly.



areas remained stable. While the effects of the move on hospital staff is beyond the scope of this report, analysis revealed the environmental factors in the new hospital affecting supply delivery and issues such as missing foam dispensers, placement of paper towel dispenser and re-stocking of supplies were significant to the staff. Over time, the staff adapted to the new location as other environmental factors were corrected at Clements.

Many social and cultural variables affect the day-to-day practice of providing patient care. Some of these cultural factors can have a profound effect on how, when, to whom with whom we communicate. The aviation industry first defined “authority gradient,” referring to the established or perceived command and decision-making power hierarchy in a team or group situation [2, 3]. In 1999, the IOM identified “authority gradient” as an obstacle to improvement in healthcare, and recommended the development of a working culture in which communication flows freely regardless of authority gradient [20]. Inadequate supervision, failures to correct problems, environmental influences, and willful violations of standard procedures also contributed to the system’s poor hand hygiene compliance.

Any effective culture intervention demands strong support and role modeling from medical, nursing, and administrative leadership. It is important to discuss issues openly and provide feedback to the workforce, which raises awareness about acts that can potentially harm patients [9, 15, 16, 18, 36, 41-56]. Hierarchies that are present in AMCs were addressed through raising awareness, garnering support from the most senior leaders, and through improving and practicing communication skills, and applying those skills consistently during routine operations. These activities were performed purposefully with the intention of helping to reduce the risks that might present due to steep authority gradients.

Managers and team leaders must be capable of creating a working climate where team members are confident enough to raise concerns, question decisions and offer solutions. This requires the development of a flexible and professional leadership style where engaging in safety-promoting behaviors is encouraged, clearly communicated, and reinforced by leaders and peers [57, 58]. We believe that the improvement, spread, and sustaining of appropriate hand hygiene practices could not easily be accomplished without the visible and active

support of the most senior physicians and administrators of the organization. Although management sets tone, responsibility for safety should be acknowledged as the responsibility of all employees. In a safety culture, all who work within the organization should be actively involved in identifying and resolving safety concerns and be empowered to take appropriate action to prevent patient harm [41, 56].

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Can that be flashed? A process improvement initiative for cranial bone flaps with positive bacterial cultures

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ABSTRACT

Abstract: In cranial surgery, when bone flap replacement is delayed, bacterial cultures and cryopreservation are indicated. There are no practice guidelines to manage positive bacterial cultures on autologous bone flaps. In 2013 Health Sciences North (HSN) Infection Prevention and Control department staff (HSN IPAC) learned of two occurrences where Immediate Use Steam Sterilization (IUSS) was used in an attempt to sterilize contaminated autologous bone flaps. The goal of this project was to identify and implement a standard of practice to address the perceived need for sterilization of contaminated bone flaps without IUSS.

Project: IPAC HSN studied practices from harvest of the bone flap to re-implantation. This review included discussions with hospital staff in medical device reprocessing, neurosurgeons, and other facilities where human tissue and bone are processed and stored. Scientific publications (4,8,9,10) and practice standards (1,2,3) were reviewed. Collaboration with HSN surgical leads and senior administration clearly emphasized the need for improved harvesting and storage practices and a guided decision tool.

Results: Project participants included HSN IPAC, infectious disease physician, Medical Device Reprocessing Department (MDRD) staff, neurosurgeons, hospital administrators and surgical resource staff. The group identified improvement opportunities in the following areas: laboratory specimen collection, storage and documentation practices of the bone flap, appropriate use of IUSS and policy development. An interim guided decision tool was developed and implemented. This collaborative effort empowered staff to apply a consistent practice for cranial bone and managing positive bacterial results that do not include IUSS.

Lessons Learned: Practices for management of autologous cranial bone flaps are not clearly defined and vary significantly across Canadian healthcare facilities. A standardized process that is evidence-based is needed to reduce microbial contamination at time of harvesting and to provide disinfection practices that are validated to improve patient outcome without the use for IUSS. Ongoing review is needed with collaboration toward a national practice standard.

KEY WORDS:

IUSS; flash sterilization; cranial bone flap; autologous bone; cranioplasty

INTRODUCTION

During a craniotomy, a section of the skull or bone flap is removed to allow access to the brain below. At the end of the procedure, the flap is wired back in place. If the flap cannot be replaced during surgery, it must be stored aseptically until it can be re-implanted. In some instances, several months may elapse before this can occur. Procedures for management and storage of donated human bone are regulated (1,2,3). Guidance is available for: serological testing of the donor, microbial sampling, disinfection and sterilization procedures, storage temperatures, space allocation and documentation of the bone until received by the patient (1,2,3). These regulations do not distinguish between bones received from human donor vs. autologous bones.

In the absence of specific guidelines for autologous bones, facilities that perform craniotomies and require bone storage follow due diligence by creating in-house practices based on tissue bank standards. As such, variations in practice from facility to facility can occur (4,5,6). There is a lack of guidance when an organism is identified on autologous bone following harvest and storage and variations in outcomes are noted in attempts to disinfect this bone prior to re-implantation. Variations also exist for

serological testing requirements in patients receiving autologous bone. IUSS is a process for use only in emergency situations, and is based on strict parameters that include time, temperature and pressure. Additional requirements for IUSS include: medical device instructions from the manufacturer for stringent cleaning and disinfection prior to sterilization. IUSS should not be used on any device that will be implanted, or to accommodate operative scheduling or lack of instrumentation (7). Placing human bone in IUSS is a not a validated sterilization process. When two events took place at HSN using IUSS in an attempt to sterilize a bone flap with positive bacterial growth, procedures were reviewed and consultation with provincial stakeholders was sought in an effort to determine if a standard of practice was needed. At the time of publication, the two instances of IUSS use had not resulted in any adverse events for the patients involved.

METHODS

Following the notification of the IUSS events, HSN IPAC set out to attempt to determine root causes. This investigation included review of practices at our facility, from harvest of the bone to re-implantation. Neurosurgical resource staff in the Operating

Acknowledgements

We gratefully acknowledge the support and collaboration of the department of Neurosurgery, Operating Room resource staff, Microbiology staff and the Infection Prevention and Control team at Health Sciences North.

TABLE 1: Telephone Questionnaire Results Collected from Canadian Facility IPAC staff or Operating Room Staff

Question	Yes	No	Unsure	No reply
1. On harvesting of the patient's bone flap do you collect bacterial samples of the bone?	10			1
2. Do you also collect serological testing for blood borne pathogens at this time (HIV, Syphilis etc.?)		10		1
3. Are the microbial results reported to the surgeon and/or IPAC?	10			1
4. Do you have a policy that guides the OR staff on the practices for harvesting and management of cranial bone flaps?	8	1	1	1
5. Has a bone flap ever been processed using IUSS due to positive cultures prior to re-implantation?	5	4	1	1

Legend: yes answer agrees with question
 No answer disagrees with question
 Unsure answer is unsure of who could answer this question or what answer would be
 No reply is facility did not return calls after 2 voicemail messages were left

Room was interviewed to determine processes for handling cranial flaps with delayed implantation. Surgeons were engaged in the process at each step towards a collaborative outcome. IUSS practices were reviewed, including policies and IUSS event logs. Facility policies for cranial bone flap re-implantation were compared against published standards from the American Association of Tissue Banks (1). Specialists in medical device sterilization were identified using the IPAC Canada Resource Member and Source Guide (11), and their expert opinion was sought. An Internet search identified several large hospitals from eastern, western and central Canadian provinces. These facilities websites were examined to determine if neurosurgery was a specialty. The facilities that performed craniotomies were contacted by phone to discuss their standard of practice for the care and management of autologous cranial bone flaps with delayed implantation or use of IUSS for autologous bone. Eleven Canadian facilities were identified as performing craniotomy procedures. A five-point questionnaire was used to inquire about management of autologous bone flaps and processes when contaminated bone flaps were encountered. Evaluation of the questionnaire by HSN IPAC provided face validity. See Table 2. Calls were directed to appropriate Operating Room staff when IPAC department staff could not answer questions. Voicemails were left and follow-up emails were sent requesting response to the question "have you any experience with having to utilize IUSS for a cranial bone flap." Two years of microbiology data from HSN was reviewed retrospectively to determine if other positive bacterial sampling results had been identified on cranial bone flaps. IUSS event logs were inspected for the same time period. An IPAC Canada member of the Ontario Provincial Infectious Disease Advisory Committee (PIDAC) was contacted via email for feedback on IUSS and autologous bone. A comprehensive literature search was also performed by the librarian at HSN using PubMed, Medline, CINAHL, Cochrane, Google, Database of Abstracts of Reviews of Effects, with the key words: cranioplasty, autologous cranial bone flap, bone and tissue storage, flash sterilization, IUSS.

TABLE 2: Hospitals Polled for Questionnaire by Province

Hospital Number	Canadian Province
1	Quebec
2	Alberta
3	British Columbia
4	British Columbia
5	British Columbia
5	Saskatchewan
7	Saskatchewan
8	Ontario
9	Ontario
10	Ontario
11	Ontario

RESULTS

Bacterial sampling and reporting

The standard for bacterial sampling of donor bone at harvest (1) includes aerobic and anaerobic specimens collected aseptically prior to wrapping and storage. Observation of practices identified some gaps when compared to posted facility policies. Culture tubes were occasionally opened at the beginning of the case and left on the sterile set up until needed, potentially explaining the resulting contamination. Location of sampling from the bone surface was not identified leaving staff to their discretion for interior or exterior bone surfaces. When final results were broadcast by the lab in an average of five days, there were inconsistencies in notification to surgeons. The documentation log kept in a central location at the bone freezer did not record if surgeons were notified or if any action was taken as a result of the notification. This documentation was recorded in the patient's medical record. With these inconsistencies, surgeons struggled with a perceived need for urgent sterilization on the day of bone flap re-implantation as several months may have elapsed since the original surgery and notification of lab results.

Storage parameters and documentation

Published standards for bone storage and expiry limits of 6 months or five years are dependent on documented temperature recording of -20°C or -40°C respectively (1). Observations of practice pointed to gaps in documentation of storage temperatures. The dedicated freezer was electronically monitored and would alarm at a central location when temperature parameters were exceeded, but the temperature data logger on the freezer had not been set up or utilized. Expiry dates for bone were not addressed in the policy and some stored bone was beyond the expiry date of five years. The freezer logs were reviewed for documentation gaps. Notification documentation was enhanced by adding an additional column to include dates, signatures, and actions taken to facilitate tracking and timely follow-up as needed. Expired bone was addressed with the respective surgeon.

Literature on the subject of autologous bone management and storage (4) identified a wide variety of practices across polled Australian neurosurgical centers and recommended further research but no Canadian-based references could be located. Other studies highlighted patient outcomes with respect to bone viability and cryopreservation methods, but

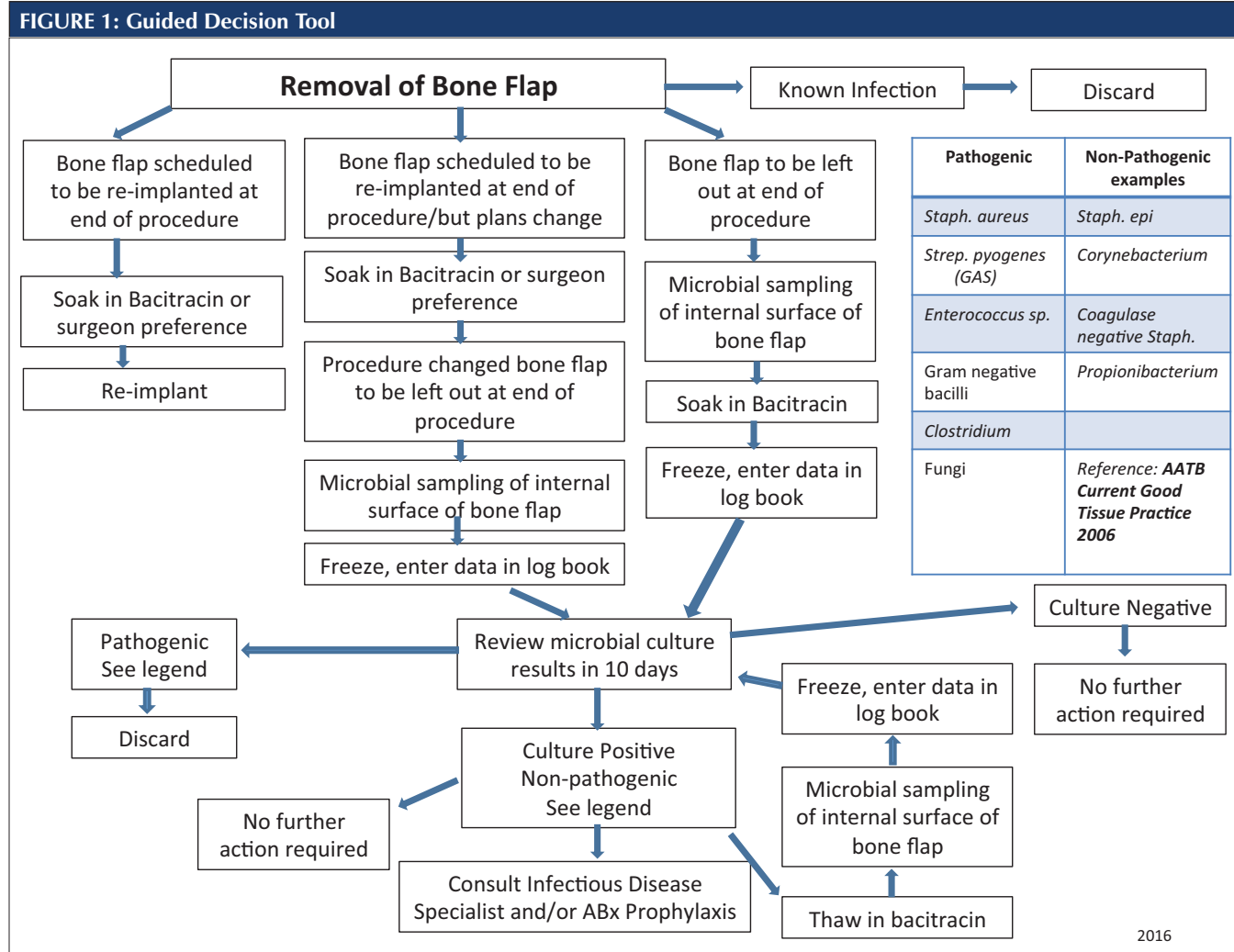
were lacking in discussion about IUSS as a management tool (8,9). One 20-year-old study endorsed the use of the autoclave suggesting it is readily available in the operative setting, and indicated it is a simple method before re-implantation (10).

Flash logs and bone flaps

A retrospective review of IUSS logs revealed previous use on cranial bone flaps. Anecdotally, surgeons also reported having used IUSS for bone flaps before; unaware this was not a validated practice. Admittedly they used equipment readily available to them in the operating room. Logs were reviewed and signed by Operating Room managers, and incident reports were filed with almost every occurrence.

Validated standards for management of donor tissue and bone (1) articulate processing steps which include cleaning of bioburden, sterilization by Gamma irradiation, followed by storage temperature and expiry date criteria (1). Gamma irradiation sterilization is not an option for HSN.

(Table 1) Eleven Canadian facilities were contacted to determine frequency of IUSS use; a total of five utilize IUSS for management of contaminated bone. Some facilities have policies that guide this practice. Four of 11 do not use IUSS, 1/11 was



unsure and 1/11 did not reply to requests. Expert leads at the provincial level were also consulted who confirmed this is not a validated use of IUSS. Admittedly some facilities were reluctant to discuss IUSS for human bone based on infrequency of the occurrences and lack of guiding policies.

Guided Decision Tool

HSN participants involved in this process improvement initiative included hospital administrator, infectious disease physician, neurosurgeons, Operating Room resource staff, MDRD and IPAC. Staff met to discuss findings of the incident, results of the internal investigation, review published standards for bone and tissue banking and appropriate IUSS use and documentation. Participants were actively involved in training updates and facility policy revisions that reflected best practice. An interim guided decision tool was developed by the group to assist staff and surgeons with the appropriate management of bone, storage, documentation and the course of action for bone flaps with positive bacterial growth. Bacterial sampling and reporting instructions were revised to provide clear direction for collecting, documenting and reporting timelines. If positive cultures were identified, staff was guided to take further action and consultation or no further action based on identified criteria (See Figure 1).

DISCUSSION

When faced with delayed re-implantation of a cranial bone flap, a standardized, evidence-based management plan is essential to achieve the best patient outcomes. This management plan should involve all stakeholders in a collaborative process. These instructions should include but are not limited to: a process for harvesting of the bone flap, bacterial sampling, bone storage, monitoring of temperatures and documentation, timely reporting of bacterial sampling results and a guided decision tool that does not include immediate use steam sterilization. By engaging all involved stakeholders in a collaborative process, opportunities for improvement were identified and a sustained change in practice was realized. When a thorough review was conducted, it was noted a small number of literature articles discussed IUSS as an option for cranial bone disinfection, we postulate may have contributed to some surgeon confusion around the acceptability of this process. There are several limitations to this process initiative. When IPAC and Operating Room staff in Canadian healthcare facilities were contacted, staff were at times unsure/reluctant about disclosing information around IUSS practices at their facilities. This may have been a factor in documenting inaccurate questionnaire results and may have resulted in under-reporting of actual practices. Validity in self-disclosure information by email correspondence may not be reliable when anonymity is not guaranteed (12).

An environmental scan of craniotomy-related infection prevention and control practices demonstrated that although IUSS is being used for human bone, such standards are recognized as substandard and may inadvertently contribute to a replication of errors or erroneous practices from facility to facility. We recommend a national collaboration to facilitate an audit of IUSS practices and management of autologous cranial bone flaps.

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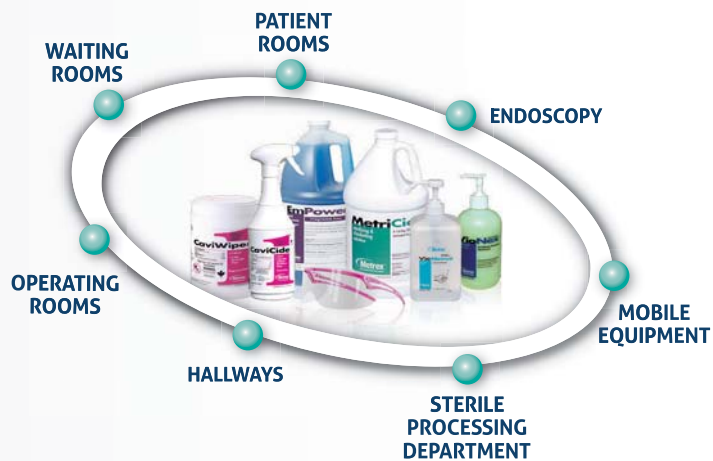
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Applied and Environmental Microbiology p. 3037–3044 Removal and Transfer of viruses on food contact surfaces by cleaning cloths.

Kirsten E Gibson, Philip G. Grandall and Steven C. Ricke

“The microfibre cloth evaluated in our study had a mean log10 reduction of 3.36 for viruses when used as a damp cloth on both surface types”

“Microfibre cloths also demonstrated significantly less transfer of viruses to surfaces than non-woven fabric.”

Journal of Hospital Infection 78 (2011) 182e186

Assessing the efficacy of different microfibre cloths at removing surface micro-organisms associated with healthcare-associated infections.

“Overall results for the single use cloth trial indicated a mean log10 reduction of 2.21 in the number of micro-organisms on the surfaces following cleaning with the microfibre cloths”

“it is concluded that use of the microfibre cloths investigated is an effective way to reduce the levels of MRSA, E. coli and C. difficile (in spore form) on a range of surfaces found in the clinical environment and could therefore be of benefit to these environments.”

“Effort should also be focused on ensuring that microfibre cloths are used correctly in real-life situations, through provision and application of manufacturers’ instructions for use.”



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Suzanne Rhodenizer Rose, RN, BScN, MHS, CIC

President, IPAC Canada

Embrace your **inner deviant!**



A long time ago, 6th century BCE actually, Lao-Tzu's Tao Te Ching was credited with saying the following:
Learn from the people
Plan with the people

Begin with what they have

Build on what they know.

Of the best leaders,

When the task is accomplished,

The people all remark.... We have done it ourselves

Positive deviance has to be one of the most useful tools that an infection prevention and control professional can have in their toolkit. According to the Positive Deviance Initiative, co-pioneered by Jerry and Monique Sternin, it has been based on the observation that in every community, there are certain individuals or groups whose *uncommon behaviours and strategies* enable them to find better solutions to problems than their peers, while having access to the same resources and facing similar or worse challenges. Our traditional kit has been filled with educational brochures and posters, best practice guidance documents and policies, accreditation standards and the occasional bag of chocolate bribery. How is that working? My own experience is that it is a tried and tired approach. Infection Prevention & Control teams have often "owned" the issues associated with preventing healthcare-associated infections. I recently heard a senior nursing leader say within my earshot that it was "infection control's policies, otherwise we would do it differently." Well then *Game On!* Because we don't need to own these issues – the people who need to initiate, implement, and live with these best practices need, in turn, to own them; the results, may they be intended (improved patient outcomes) or unintended outcomes

(outbreaks, increased morbidity and mortality, higher than acceptable rates of healthcare-associated infections, and the list goes on) – those need to be owned as well.

At risk of sounding like a broken record, it is time for us in the field to take a step back and redefine, for ourselves and others, our role on the healthcare team. Our contribution can take the shape of subject matter expert and consultant, driver of positive change, researcher and educator and facilitator of positive deviance. We have the scientific and clinical knowledge and ability to analyze surveillance data and make practice change recommendations. We can clearly educate on the science and the evidence that forms the basis of standards and best practice guidelines that have already had the benefit of enduring the typical rigors of peer-reviewed research. We can critically appraise the literature and tease out the information that addresses our gaps in policy, process and standard-setting. At times, this approach, although grounded in science, seems at odds with how life at the coalface plays out. It is about fostering a strong patient safety culture, enabling change that is sustainable over time and supporting behavior changes that evolve into accepted and more importantly, expected norms.

If we can impart knowledge and provide frontline staff with the scientific rationale and that which is evidence-informed, then these professionals are amply-equipped. They are armed with the knowledge to run with the evidence and transform it into practice changes that can be implemented in their practice settings in a manner that makes sense to staff and achieves the intended outcomes. Hallelujah! Go forth, EMBRACE deviance! Dare to explore the ways we can do things differently. It can't hurt and the consequences may excite you. And the literature certainly supports it. 🍁



Suzanne Rhodenizer Rose, IA, B.Sc.Inf., MHS, PCI

Présidente, PCI Canada

Laissez libre cours à **vos** déviances!

Il y a très longtemps, et plus précisément au vie siècle avant l'ère chrétienne, Lao Tseu aurait écrit dans le Dao de jing :

*Apprends des autres,
Planifie avec eux,*

*Inspire-toi de ce qu'ils ont,
Construis sur ce qu'ils savent.*

Une fois la tâche accomplie

Avec le meilleur des chefs, tout le monde dit :

Nous avons réussi par nous-mêmes.

La déviance positive – c'est le nom d'une initiative originale de Jerry et Monique Sternin – est sans doute l'un des meilleurs outils des professionnels de la prévention et du contrôle.

C'est un ensemble de *comportements et stratégies hors du commun* que l'on trouve au sein de toute collectivité, chez un individu ou un groupe qui arrive ainsi à trouver de meilleures solutions que les autres, malgré des ressources identiques et des difficultés semblables, voire pires. Notre trousse d'outils est habituellement constituée de brochures et d'affiches éducatives, de guides sur les pratiques exemplaires, de politiques, de normes d'agrément et, parfois même, de petits chocolats pour nous gagner les bonnes grâces des collègues.

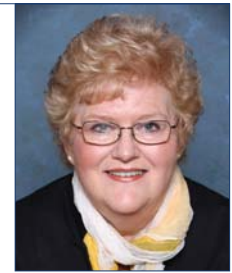
Et la déviance positive, alors? D'après ce que j'en sais, elle a déjà été largement mise à l'œuvre et à l'épreuve. Les équipes de prévention et de contrôle des infections s'approprient les difficultés associées à la prévention des infections nosocomiales. Or récemment, j'ai entendu une personne (titulaire d'un poste supérieur en soins infirmiers) dire : « Ce sont les politiques de contrôle des infections; autrement, on agirait différemment. » Ah bon? Montrez-moi, alors! Parce que nous n'avons pas à nous approprier ces questions, chaque personne qui doit instaurer et appliquer ces pratiques exemplaires et quoi doit ensuite vivre avec, doit les faire siennes. Les résultats, qu'ils soient voulus (p. ex., l'amélioration de la situation des patients) ou non (flambées, augmentation des taux de morbidité et de mortalité, taux d'infections nosocomiales supérieurs à la normale, etc.), il faut aussi que quelqu'un les fasse siens.

Au risque de sonner comme un vieux disque rayé, je dirais qu'il est temps pour nous, gens de terrain, de prendre un peu de recul et de redéfinir notre rôle au sein de l'équipe de soins, pour notre gouverne et pour celle des autres. Notre contribution est celle de spécialistes en la matière, de conseillers, d'agents de changement, de chercheurs, d'éducateurs et de défenseurs de la déviance positive. Nous avons les connaissances scientifiques et pratiques de même que la capacité d'analyser les données d'observation qui permettent de recommander des changements de pratique. Nous pouvons à l'évidence expliquer



les données scientifiques et les données probantes qui fondent les normes et les directives déjà soumises à la rigueur typique de l'examen par les pairs. Nous pouvons porter un regard critique sur la littérature et en extirper l'information qui comble nos lacunes quand vient le temps d'établir des politiques, des processus et des normes. Cette façon de faire, fondée sur la science, semble parfois à des kilomètres de la vie en première ligne. Mais il s'agit d'instaurer une solide culture de sécurité, d'apporter des changements durables et de favoriser des changements de comportement qui seront acceptés, et surtout, qui deviendront la norme.

Si nous arrivons à transmettre d'utiles connaissances aux professionnels sur le terrain et à leur fournir un raisonnement scientifique fondé sur des données probantes, ils seront fort bien outillés. Ils disposeront de connaissances et de preuves cohérentes qu'ils pourront mettre à profit pour changer les pratiques d'une manière qui sera logique dans leur contexte propre et les mènera aux résultats attendus. Alléluia! Allez, laissez libre cours à votre déviance! Osez explorer l'alternative. Ça ne fait pas de mal et les conséquences peuvent être très stimulantes. Et la littérature spécialisée y est très favorable. 🍀



Gerry Hansen, BA

Executive Director, IPAC Canada

New Initiatives

The following is a summary of several initiatives that IPAC Canada is undertaking on behalf of its members.

ADVOCACY –

Nova Scotia Department of Health and Wellness

In spring of 2016, we were advised that the Nova Scotia Department of Health and Wellness has dissolved Infection Prevention and Control Nova Scotia (IPCNS), transferring responsibilities to the Nova Scotia Health Authority (NSHA). This restructuring includes changes that will jeopardize quality and safety in Nova Scotia's healthcare system across its entire spectrum of services by undermining system-wide infection prevention and control measures. People living in long-term care facilities, those travelling by ambulance, and others being treated by practitioners in allied health care professions like dental offices and rehabilitation facilities will all be left without the safeguard that the Department of Health & Wellness was working on to ensure infection prevention and control is a priority consistently adhered to across Nova Scotia's spectrum of healthcare. IPAC Canada has advocated on behalf of the people of Nova Scotia to draw attention to the deficiencies of this plan and to propose additional changes that will return expert support to all healthcare settings. Efforts to date have included a Letter to the Editor of the *Halifax Chronicle Herald*, a letter to the Nova Scotia Minister of Health & Wellness Leo Glavine, media interviews, and an in-person meeting with Minister Glavine and his staff.

Suzanne Rhodenizer Rose is on staff with the Nova Scotia Health Authority and consistently recused herself from all discussions and in the aforementioned communication/planning regarding this issue.

STANDARDIZED CASE DEFINITIONS

The National Integrated Patient Safety Action Plan identified five areas of concern: Surgical Care, Medication Safety, Home Care Safety, Patient Safety Education and Infection Prevention and

Control. IPAC Canada has taken on the role of co-lead, with AMMI Canada, to facilitate the four objectives under Infection Prevention and Control – Measurement and Surveillance:

- 1) Review current CNISP definitions for acute care and identify the challenges and barrier to use of the CNISP definitions by non-CNISP and community hospitals.
- 2) Review current LTC case definitions and add to or edit as required.
- 3) Engage provincial health authorities in the adoption of the LTC case definitions.
- 4) Prepare a business case to encourage the establishment of a National Repository for data collection, analysis, and dissemination.

The IPAC Canada Surveillance and Applied Epidemiology Interest Group (SAEIG) has taken the lead in the review of case definitions and has submitted a brief to CNISP around the challenges in acute care. The Long Term Care Interest Group and l'Association des Infirmières des Prévention des Infections (AIPI) are active participants in the LTC initiative. They have reviewed and edited current LTC definitions and will be preparing their final brief in early 2017. Objectives 3 and 4 are long term and will be initially addressed in 2017.

CHAPTER COUNCIL

A Chapter Council comprised of representatives of seven identified chapter regions had its first meeting in November 2016. A communication plan was discussed as well as the process for referring chapter issues to the Council, to the Board if required, and response. The Chapter Council is designed to encourage communication between chapters and an expert group who could discuss matters affecting chapters and develop recommendations. The Council in no way replaces a Chapter Executive or regular national teleconferences and meetings of Chapter Presidents.

CANADIAN NURSES ASSOCIATION

IPAC Canada is a member of the Canadian Nurses Association (C.N.A.) Network of Nursing Specialties and our representative, Madeleine Ashcroft, has recently been elected as the Network representative to the C.N.A. Board. Recent positive news is that C.N.A. is developing guidelines for recognition of nursing specialties and certification exams, with significant input from IPAC Canada.

Many other projects and initiatives are in planning or working phrases. Watch for announcements in the monthly e-news and on our website! 🌸

The following DVDs have been removed from inventory and will no longer be sold. Content is out of date.

- Just Wash 'Em
- Families and Visitors
- Grand Prix of PPE
- SuperBugs

Three Important Documents **Recently Released**

Program Wide Standard

Infection Prevention and Control Canada (IPAC Canada) is pleased to announce the publication of the Infection Prevention and Control (IPAC) program standard as a special supplement to the winter issue of the Canadian Journal of Infection Control (CJIC). The IPAC program standard has been designed to inform senior leaders engaged with IPAC programs in healthcare organizations and IPAC program staff, of the minimum requirements for IPAC programs, across the continuum of healthcare in Canada.

Additionally, the IPAC program standard describes the culture, scope and foundational framework necessary for the development of a successful IPAC program; synthesizes best practices, guidelines and recommendations from Canadian (national and provincial) bodies and international agencies; and incorporates significant findings from the current scientific literature.

- The IPAC program standard may be used as a resource.
- For prioritizing and developing an IPAC program.
- As a way to obtain senior management support for the IPAC program.
- To ensure consistency in the recommended program elements across all Canadian health care settings, and to engage in strategic planning activities for the future.

The authors wish to thank IPAC Canada for facilitating the development of this *IPAC Program Standard and the Program Audit Tool (PAT®)*. Thanks also to the Canadian Agency for Drugs and Technologies in Health (CADTH) for valuable training of committee members in critical appraisal of the medical literature and other technical support.

IPAC Canada thanks the developing committee for their expertise and dedication to an historic initiative:

- (Co-Chair) Karen Clinker, Med, BScN, CIC, CCOHN/CM
- (Co-Chair) Shirley McDonald, ART, CIC
- Brenda Dyck, BScN
- Jim Gauthier, MLT, CIC
- Bernice Heinrichs, RN, MN, CIC
- Karen Hope, MSc, BSc
- Ramona Rodrigues, RN, BSc, MSc(A), CIC, CNS
- Marion Yetman, RN, MN, BN, CIC

Core Competencies For Healthcare Workers

In 2013, an IPAC Task Group was put together to update the Infection Prevention and Control (IPAC) Core Competencies for Healthcare Workers. This task was completed in September 2016.

BACKGROUND: The original core competencies were developed in 2006 as a set of common core competencies in IPAC that apply to all healthcare workers. The competencies were essential information that a healthcare worker¹ involved in patient² care needs to allow them to work safely and also to prevent transmission of organisms in their institution. This was done by building a Canada-wide consensus. These were published: *Henderson, EA, The CHICA-Canada Education Committee and members from CHICA Canada Chapters (2006).*

Essential Infection Control Competencies Needed by Healthcare Workers Involved in Patient Care: A Canadian Consensus. Canadian Journal of Infection Control 21(1): 62-7. The competencies were categorized into 6 areas: basic microbiology, hand hygiene, routine practices and transmission-based precautions, personal protective equipment, personal safety, sterilization and disinfection and critical assessment skills.

PURPOSE: The initiative was to update the set of common core competencies in Infection Prevention and Control that apply to *all healthcare workers across all healthcare sectors*. The scope of Infection Prevention and Control and IPAC Canada was expanded to include community, pre-hospital and public health including both regulated and non-regulated health care settings. The competencies were reviewed to reflect this change in scope as well as to reflect practice changes that have occurred in the last 10 years including the worldwide Ebola outbreak. These basic core competencies serve as a platform for adding occupation specific competencies.

The objective was to identify the specific competencies healthcare workers need to be able to do to protect themselves in their working environment as well as protecting their patients/ residents/clients. There was no attempt to identify who is responsible for ensuring healthcare workers meet these competencies. Some competencies will fall directly within the purview of Infection Prevention and Control while others will be outside. These competencies can be used to develop training for existing healthcare workers and can be distributed to institutions across Canada for integration into training programs for all future healthcare workers.

CORE COMPETENCIES: The Task Group updating the competencies consisted to eight individuals from across Canada who can from many of the different healthcare sectors. Once developed, the competencies were sent to the IPAC-Canada Chapters and the Board for input.

The updated health care worker core competencies were expanded into 13 categories listed below. The competencies cover the same general areas of knowledge and skills identified in the original competencies. The updated competencies often identify a very specific knowledge and skills that reflect changes in IPAC practices. They reflect the trend towards the use of “horizontal” rather than “vertical” IPAC practices. The updated core competencies fall into these categories:

- Understands basic microbiology.
- Understands the “Chain of Infection.”
- Understands the importance of Surveillance.
- Understands and demonstrates the use of “Point of Care” Risk Assessment.
- Understands and Uses Routine Practices.
- Understands the importance of Hand Hygiene and can demonstrate acceptable methods.
- Understands and demonstrates use of appropriate personal protective equipment (PPE).
- Understands and demonstrates the use of Additional Precautions: why and when they are used.

- Understands the difference between general, biomedical, pharmaceutical or biohazardous wastes.
- Understands how to appropriately prevent and manage occupational exposures to sharps and blood and body fluids (Workplace Health and Safety).
- Understands the role of vaccine in preventing certain infections including annual influenza immunizations.
- Understands the cleaning, reprocessing and storage requirements for health care equipment
- Critical Thinking.

The following members of the review committee are acknowledged, with many thanks:

- (Chair) Elizabeth Henderson, PhD
- Greg Bruce, A-EMCA
- Fernanda Cordeiro, RN, BScN
- Suzanne Rowland, RN, BScN, CIC
- Faith Stoll, RN, BScN, CIC
- Marilyn Weinmaster, RN, BScN, CIC
- Nina Williams, RN, BN
- Marion Yetman, RN, BN, MN, CIC

Core Competencies For ICPS

Since 1999, when IPAC Canada and APIC first published professional and practice standards for infection prevention and control (IPAC), much has changed in the IPAC world, including expansion of continuing education opportunities for infection control professionals (ICPs) and of ICPs' responsibilities. IPAC Canada, like other organizations, has therefore developed a set of 157 competency statements, in 14 competency areas, that indicate the minimum knowledge, skills and attitudes required to practice safely and ethically as an ICP. These were finalized after several rounds of feedback, first from topic-specific experts, then general experts, and finally from IPAC Canada Chapter members. This approach allowed us to obtain feedback from key experts and end users to ensure that the competencies are grounded in current practice in Canada.

Box 1 summarizes the 14 competency areas, which are grouped as foundational, applied and supporting core competencies, although there may be some overlap between competency areas. The Foundational core competencies reflect the basic knowledge and skills that are required for all aspects of IPAC and that the competent ICP will draw on daily. The Applied core competencies reflect the knowledge and skills that

will not be required on a daily basis but rather as specific issues arise. The Supporting core competencies are not IPAC-specific but rather reflect the overarching knowledge and skills required by a competent ICP to assist with the effective functioning of an infection prevention and control program.

A competent ICP is one who is able to perform effectively in the roles and functions required by his or her position and within the team and organization. It is expected that ICPs in any healthcare setting have knowledge and skills in all of the competency areas, although not all of the core competencies identified would necessarily need to be applied in all work settings.

Specific competencies for novice and expert levels of ICP have not been defined but it is expected that ICPs and their managers can use the core competencies to guide performance appraisal and related professional development activities. Competence and expertise can thus be recognized and areas for growth and strengthening can be articulated. Individuals will vary in the amount of time, types of resources, and types of learning experiences needed to develop different competencies, depending on their knowledge, experience, environment, and healthcare setting. The core competencies document can also be used to guide programs and educational offerings.

Articulating core competencies is a key first step; ICPs and organizations now need to utilize the competencies to set and meet expectations for consistent professional practice that will translate to safer work and healthcare environments and to quality of care. *IPAC Canada's Core Competencies for ICPs* are now ready for use!

IPAC Canada would like to thank the experts and members of IPAC Canada who reviewed the document and provided valuable suggestions. We would also like to thank the developing committee for their dedication to the launch of this important IPAC Canada document:

- Donna Moralejo, PhD (Chair)
- Barbara Catt, RN, BScN, Med, CIC (Co-Chair)
- Madeleine Ashcroft, RN, BScN, MHS, CIC
- Helen Christou, RN, DOHN
- Katherine DeFalco, RN, BScN, CIC
- Brenda Dyck, BScN
- Suzanne Rhodenizer Rose, RN, BScN, MHS, CIC

These documents are available on the IPAC Canada website at this link: <http://ipac-canada.org/ipac-canada-publications.php>. *

Box 1: Core Competencies by Category

	Foundational	Applied	Supporting
IPAC-specific	Yes	Yes	No
Applied when	In daily practice	As specific issues arise	In daily practice
Core competency categories	Education Microbiology Routine Practices and Additional Precautions Surveillance and Epidemiology Research Utilization	Health Care Facility Design, Construction, Renovation and Maintenance Occupational Health and Safety Outbreaks and Infectious Disease Threats Quality Improvement and Patient Safety Reprocessing of Medical devices.	Communication Leadership Management Professionalism

2017 SealedAir Diversey Scholarship

Through the generous support of SealedAir Diversey, 16 IPAC Canada members were supported to attend the 2016 annual conference. The recipients include members with novice, intermediate, and advanced expertise. IPAC Canada thanks SealedAir Diversey for the opportunity for selected

candidates to have the support needed to attend the conference. We commend all applicants for the quality of their work in infection prevention and control. Online applications for the 2017 scholarship are accepted up to **January 31, 2017**. Guidelines are available at <http://ipac-canada.org/sealed-air-diversey-scholarship.php>. *



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Moira Walker Memorial Award for International Service

This award honours an individual or group that has demonstrated extraordinary efforts to bring about change or improvement related to infection prevention and control in parts of the world that are under developed or under resourced. The annual award is in honour of Moira Walker, RN, CIC, a Past President of IPAC Canada (formerly CHICA Canada) and Past Honourary Secretary of the International Federation of Infection Control. Moira's life was dedicated to enhancing the physical and spiritual health of her many friends and colleagues.

NOMINATION GUIDELINES

Preferred: Current IPAC Canada members in good standing

The award may be presented to individuals, prior nominees, or a group of individuals, but not past award recipients, who have demonstrated international cooperation in the field of infection prevention and control or public health. Fundraising efforts alone will not be sufficient criteria for this award. Lifetime achievement in international service would be considered.

Who May Nominate

Any member of IPAC Canada or a chapter of IPAC Canada may submit a nomination. The IPAC Canada Board of Directors (the Board) may also nominate candidates. The nomination form is available at www.ipac-canada.org (Opportunities).

How to Nominate

A completed nomination form and covering letter outlining the nominee's projects that have resulted in this nomination must be forwarded to the Membership Services Office no later than March 31st of each year.

Selection Process

The Board will select the recipient(s) through an evaluation process.

Award

Artwork with a First Nations and Inuit art theme. The accompanying engraved plate will announce the recipient's award. In addition, award winner(s) will be provided with travel (economy) to the 2016 conference, two nights' accommodation, and a complete waived registration for the national education

conference at which the award is presented. In the case of a group award, one representative of the group will be provided with the full award.



Deadline

The deadline for nominations is **March 31, 2017**.

Announcement and Presentation

The award winner(s) will be advised by April 15th of each year. The award will be presented at the Opening Ceremonies of the IPAC Canada National Education Conference.

Award Sponsor

The Moira Walker Memorial Award for International Service is made possible through the generous support of Sage Products LLC. *



2017 Champions of Infection Prevention and Control

In collaboration with 3M Canada, IPAC Canada established the Champions of Infection Prevention and Control Award in 2009.

The Award recognizes IPAC Canada members who have demonstrated innovative initiatives to prevent infection, raise awareness, and improve the health of Canadians.

The candidate may also be nominated for lifetime achievement. The nomination may be made by a member of IPAC Canada or by an IPAC Canada chapter. Formal presentation of the Award will be made at the Opening Ceremonies of the 2017 National Education Conference (Charlottetown, June 18, 2017).

Deadline for 2017 nominations is **March 1, 2017**. *



Bring in a **New Member!**

Membership has its benefits – education, collaboration and representation. The IPAC Canada website (www.ipac-canada.org) has so much information on the benefits of being a member. The annual member resource guide for finding other IPAC Canada members, links to infection control sites, audit tools, the audit tool app, upcoming mentor program, Learning Object Repository...the list is extensive. Tell another Infection Prevention and Control Professional (ICP), tell an infection control or ID physician, tell your Medical Laboratory Technologist, tell Environmental Services, tell EMS, tell your designate, and tell your director about the benefits of joining our national organization.

If that person joins IPAC Canada by March 1, 2017, both you and the new IPAC Canada member will be eligible to win a complimentary 2017 conference registration (Monday-Wednesday, value \$650). You are eligible for the draw with every new IPAC Canada member that you get to sign up from June 1, 2016 to April 30, 2017 inclusive. Should the winning members have already paid their 2017 conference registration, a refund will be made to the person or the institution which has paid the fee. The New Member Contest form is available from www.ipac-canada.org or by contacting the IPAC Canada office. An announcement of the winners of this offer will be made by March 15, 2017. Membership applications can be found at http://www.ipac-canada.org/about_join.php. 🍁



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2017 ECOLAB poster contest



An annual poster contest is sponsored by Ecolab and supported by a chapter of IPAC Canada to give infection prevention and control professionals (ICPs) an opportunity to put their creative talents to work in developing a poster which visualizes the Infection Control Week theme. 2017 National Infection Prevention and Control Week is October 16-20.

THEME: Infection Prevention and Control – It’s a Team Thing!

PRIZE: Waived registration to 2017 IPAC Canada National Education Conference or \$500.

REMINDER: Posters should have meaning for the public as well as all levels of staff across the continuum of care. The poster should be simple and uncluttered, with strong visual attraction and minimal text.

Judging will be on overall content. Artistic talent is helpful but not necessary. The winning entry will be submitted to a graphic designer for final production. Your entry will become the property of IPAC Canada.

HOST CHAPTER: IPAC Nova Scotia

SUBMISSION: Submissions will only be accepted by email. Send submission to info@ipac-canada.org.

Email title: 2017 Ecolab Poster Contest

Submission format:

- Electronic file in Word or PDF format only.
- Files less than 5 MB preferred.
- File Size – must print out to 8.5"x11" paper.
- Name, address and telephone number must be included in the covering email.
- DO NOT include identifiers in the poster submission.

DEADLINE: January 31, 2017 *

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Jackie E. Nugent, RN, BSCN, CIC
Paula C. Stagg, RN, MN, CIC

Recertified

Banu Bayar, CIC
Karen L. Campbell, MLT, BAsC, CIC
Heather L. Candon, BSc, MSc, CIC
Clotilda A. D'Silva, PhD, CIC
Brenda J. Dewar, CIC
Dhananjaya Gonchicar, CIC
Leanne M. Harding, RN, ETN, CIC
Marianita Lampitoc, CIC
Bryan Morales, RN, BScN, CIC
Joan Osbourne Townsend, RN, MN, CIC
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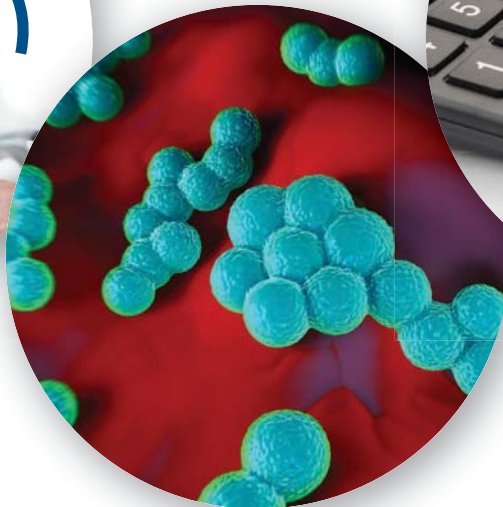


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Reference: 1. Kelly, J. W., MD, Blackhurst, D., DrPH, McAtee, W., BS, & Steed, C., MSN, RN, CIC. (2016, June 23). Electronic hand hygiene monitoring as a tool for reducing health care-associated methicillin-resistant Staphylococcus aureus infection. *American Journal of Infection Control*.

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2017 Annual General Meeting

NOTICE IS HEREBY SERVED that the Annual General Meeting (AGM) of Infection Prevention and Control Canada will be held on Wednesday, June 21, 2017 at the Prince Edward Convention Centre, Charlottetown, Prince Edward Island. Registration will open at 0715. IPAC Canada members must register and pick up a voting card before entering the AGM. The AGM will commence at 0745. Registration will close at 0745 and the doors will be closed. After the doors

are closed, attendees may enter the AGM, but may not vote unless registered.

Members may vote on business arising at the AGM by proxy using Form #15 2017 which must be submitted to the IPAC Canada Secretary at the IPAC Canada office no later than Monday, June 19, 2017. The AGM Agenda, Rules of Order and Proxy Form #15 2017 will be posted to the website in early 2017 and an announcement made of their availability. *

Marilyn Weinmaster, Secretary
IPAC Canada
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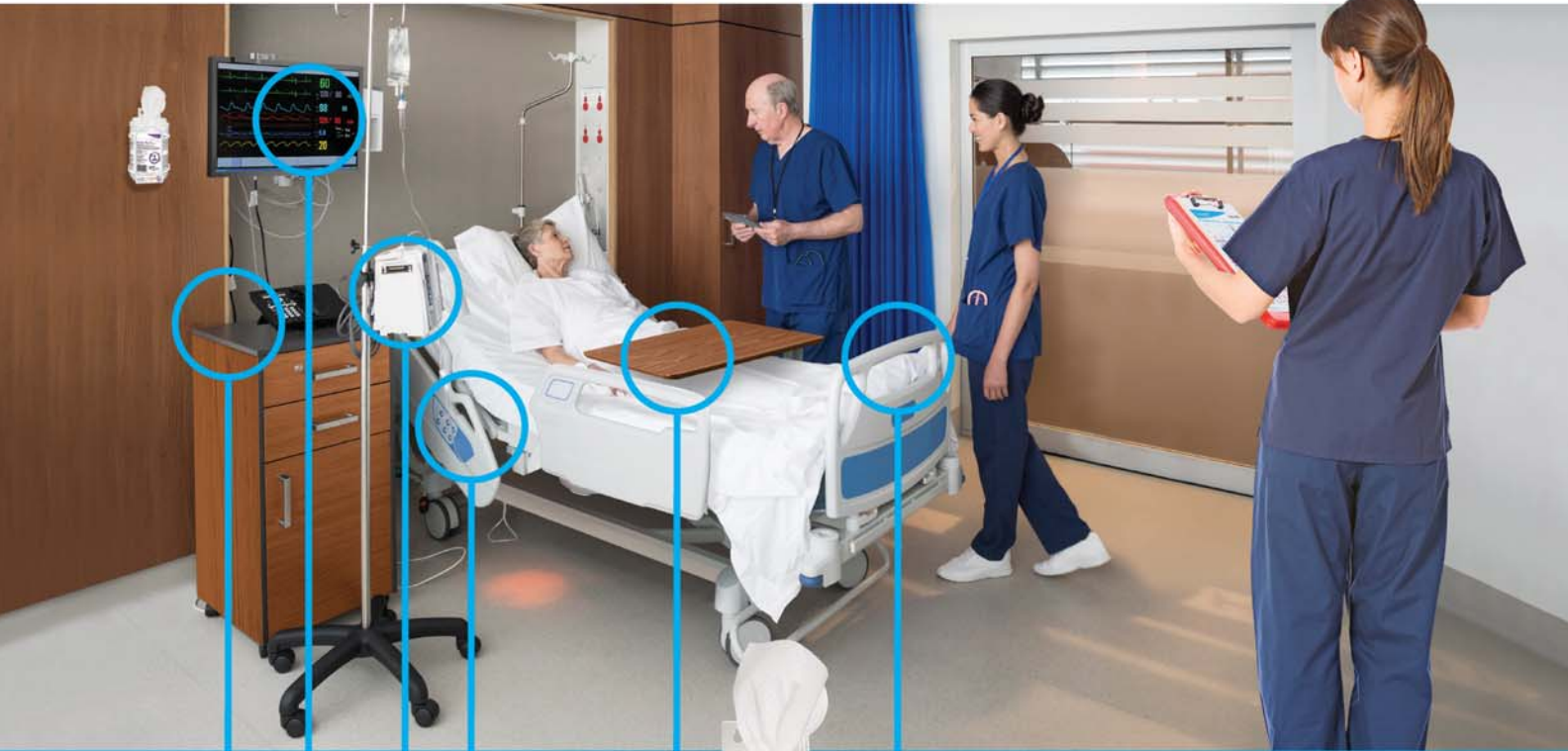
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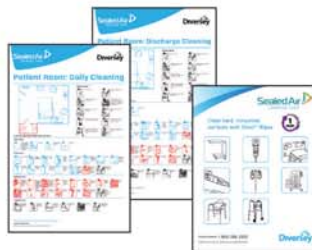


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¹ Public Health Agency of Canada, 2013

² Public Health Agency of Canada, 2016