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IP International Journal of Medical Microbiology and Tropical Diseases

Journal homepage: https://www.ijmmtd.org/

Original Research Article

Reducing hospital-acquired infections and improving the rational use of antibiotics in a tertiary care hospital in Bangalore

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ARTICLE INFO

Article history:
Received 30-06-2022
Accepted 18-07-2022
Available online 06-09-2022

Keywords:
Hospitalacquired infection
Hand hygiene
Antibiotic stewardship

ABSTRACT

Background: Prevention of hospital-acquired infections (HAI) is central to providing safe and high quality healthcare. Transmission of infection between patients by health workers, and the irrational use of antibiotics have been identified as preventable aetiological factors for HAIs. Few studies have addressed this in developing countries.

Objective: To assess the effectiveness of a multifaceted infection control and antibiotic stewardship programme on HAIs and antibiotic use.

Materials and Methods: A retrospective study was conducted for a study period of 11months (June 2021-April 2022) in Vydehi Hospital, Bangalore. All patients admitted to the intensive care unit and wards were included in the study. Intervention period was 6 months (June 2021-Nov 2021) and post-intervention period was 5 months (Dec 2021- April 2022). Assessment of HAIs was made based on the criteria from the Centers for Disease Control and Prevention. The multifaceted intervention consisted of hand hygiene campaign, isolation of multidrug resistance organism's patients, water and air quality analysis, training of health care workers in infection control practices, and antibiotic stewardship. Data was collected using an identical method in the intervention and post intervention periods.

Results: We observed a major reduction in HAIs, from 89% (198/222 patients) in the intervention period to 10.8% (24/222 patients) in the post intervention period (relative risk (RR) (95% CI) 0.48 (0.31 to 0.56). Antibiotic use in ICUs declined from 58% (780/1347) to 44% (442/995) (RR 0.44 (0.40 to 0.55). Overall, hand hygiene compliance among the health- care workers was maintained at 100% during both the periods.

Conclusion: Multifaceted infection control interventions are effective in reducing HAI rates, improving the rational use of antibiotics, increasing hand hygiene compliance, and may reduce mortality in hospitalised patients in developing countries.

1. Introduction

Even in settings with limited resources, prevention of hospital-acquired infections (HAIs) is central to providing high quality and safe health-care. The two important preventable factors involved in many HAIs are transmission of infectious agents between patients by health workers and irrational use of antibiotics.[1–3] HAIs are among the most significant causes of morbidity and mortality in healthcare settings throughout the world.[4] In developed countries, many studies have shown that infection control programme, including campaigns to improve hand hygiene, are effective in reducing HAIs.[5–7] In developing countries, studies on the effectiveness of interventions to reduce HAIs are limited.

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https://doi.org/10.18231/j.ijmmtd.2022.042

This study aimed to develop and evaluate the effectiveness of a multifaceted infection control programme on rates of HAIs, including rational use of antibiotics and hand hygiene compliance throughout the wards and ICUs of a tertiary care hospital in Bangalore.

2. Materials and Methods

The study was conducted at the Vydehi Hospital, Bangalore in ICUs and general wards. The total bed strength of the hospital is 1600.

2.1. Design

The research design was a retrospective study consisting of two periods: The intervention (6 months, June 2021 to November 2021) and the post-intervention (5 months, December 2021 to April 2022).

2.2. Sample size

Calculation of sample size was done using the formula (a difference between intervention and post-intervention groups with proportional comparison using the power of 80%, type 1 error of 5%). The study included 2,342 ICU patients admitted in Vydehi hospital from June 2021 to April 2022 (11 months). Study also included 1,398 patients admitted in the wards. A total of 5,524 post surgery patients during the same period were included for the calculation of SSI.

2.3. Inclusion criteria

Patients who remained in the ICU or wards for more than 48 h and post-surgery patients were included in the study.

2.4. Outcome measures and data collection

2.4.1. Hospital-acquired infection

Centers for Disease Control and Prevention (CDC) and National Healthcare Safety Network[8,9] definition for HAI was followed in the study. Investigations of the causes of fever and other signs of infection were at the discretion of the treating clinical staff. If clinical criteria for suspected HAIs were fulfilled and the patient had not been investigated by the treating doctors, the clinical staff was advised by the HICC team, so they could collect a culture of blood, urine or other sterile sites, as appropriate, on the same day.

2.4.2. The rational use of antibiotics

During the intervention period, the antibiotic policy was revised as per hospital antibiogram from microbiology laboratory and periodic monitoring by HICC team with emphasis on antibiotic stewardship was done. Medical record of each patient for daily antibiotic use was checked during this period. Inappropriate antibiotic use was classified according to the spectrum, dose and duration.[10,11]

2.4.3. Hand hygiene compliance

Hand hygiene compliance was defined as for each of WHO's five moments for hand hygiene, hand washing with antiseptic soap and water or alcohol-based hand rubs by the health worker.[12,13] When there was an indication for hand hygiene whether the hand hygiene compliance was achieved by the health worker and performed it correctly. Health care workers (doctors, nurses, ward boys, house keeping staff and technicians) were systematically observed over a fixed time period (20±10 min each). During these periods of observation, the actions of the first health worker who was involved in the care of the patient was recorded by the Infection control nurses.[14] Direct hand hygiene observation began when the healthcare worker entered the patient's room or bed area and was observed during activities that involved contact with the patient or their environment, and the observation ended when the healthcare worker completed the activity and left the bed space.

2.4.4. Bacterial culture

According to CLSI guidelines, bacterial isolation and antibiotic susceptibility testing were performed.[15] Vitek-2 (Bio-Mereuix) was used for all specimens except blood for which the BACTEC 9120 (BD Diagnostics, Sparks, Maryland, USA) was used. For each positive culture result, isolated organism, time taken for culture positivity, number of positive culture sites, the presence of focal or generalized clinical signs of infection and an overall assessment of illness were recorded. This enabled an assessment of whether the isolate was a true pathogen or a contaminant

2.4.5. Intervention period

Engaging the target group prior to the commencement of the intervention, HICC team reviewed the pre-intervention data and to provide feedback about the educational tools to be used and the implementation processes.

2.4.6. Intervention phase

Educational seminars, reminders, audit and performance feedback on all aspects of infection control were the tools used in the intervention aimed to reach all doctors, nurses and allied workers at the wards and ICUs. Seminars were conducted at least twice for each topic for approximately 1 h to cover all the health workers on different shifts. Topics of the seminars and other interventions were related to HAIs, hand hygiene practices, isolation of MDRO patients, water and air quality analysis, improving the rational use of antibiotics based on antibiotic policy and measures to prevent central line associated bloodstream infections, ventilator associated pneumonia, catheter associated urinary tract infections, and surgical site infections.

The HICC team consisting of doctors and the infection control nurses provided the seminars and feedback to the health workers. During the intervention period, the audit data were also collected and feed back to the health workers individually were given, and were presented at the monthly HICC meetings.

A bottle of alcohol hand rub had already been made available in every patient care room and another bottle was placed at the entrance of each room. There was a water sink and antiseptic soap in every ward.

2.4.7. Post-intervention period

In the, intervention and post-intervention periods, an identical method was used to collect data. While the main educational push was in the 6-months intervention period, ongoing education was provided where needed. This was the rationale for including the intervention period in the analysis of effectiveness.

2.4.8. Outcome measures

The primary outcome was the proportion of patients with a HAI, between the intervention and post-intervention periods. Secondary outcomes were the proportions of patients who were exposed to inappropriate antibiotic use, healthcare workers 'compliance with hand hygiene.

2.5. Data analysis

When comparing proportions from both time periods, the Chi-sqauare test was used to analyse the results . For comparison of means student t test was used. The statistical significance was set at $p<0.05$. To compare the effect of the interventions between both periods, the relative risk (RR) was also calculated. To quantify the relationship between the HAI and the multifaceted intervention allowing for statistical control of potential con-founders Regression analyses were used. Vydehi Institutional Ethics Committee approved the study.

3. Results

3.1. Study population

A total of 2,342 ICU patients, 1,398 ward patients and 5,524 post- surgery patients were enrolled between 1^{ST} June 2021 and 30^{th} April 2022 (11 months).

3.2. The effectiveness of the multifaceted intervention on HAIs

The number of patients developing HAI decreased from 89% (198/222) in the intervention period to 10.8% (24/222) in the post-intervention period (relative risk (RR) (95% CI) 0.48 (0.31 to 0.56) (Table 1).

The reduction was observed gradually and consistently during the post-intervention period as the analyses of HAI incidence every 4 months showed. (December 2021 to April 2022) (Table 1).

The use of urinary catheters in ICUs (catheter days) decreased significantly from 60.6% (2862/4720) to 39% (1858/4720) in the post-intervention period (p=0.01). Consequently, from 32% in the beginning of intervention period to 4.3% in the post-intervention period CAUTI dropped significantly (Table 2), showing the effectiveness of the intervention with RR=0.24(95% CI 0.11-0.49).

The use of invasive devices in ICUs and HAIs related to invasive devices was varied in the post-intervention period. The use of central line catheters increased from 14.2% (191/1,347) to 19.8% (197/995) in the post-intervention period (p=0.007).The Central line catheter days decreased from 65% (802/1234) in the intervention period to 35% (432/1,234) in the post-intervention period (p =0.10). CLABSI decreased significantly from 31% during the beginning of intervention period to nil in the post-intervention period RR 0.45 (95% CI 0.33 - 0.62) (Table 3).

The use and the duration of mechanical ventilation (ventilator days) decreased from 74.5% (1,985/ 2666) in the intervention period to 25.5% (681/2,666) in the post-intervention period (p=0.12). Consequently, the risk of developing ventilator-associated pneumonia decreased significantly from 45% during the beginning of intervention period to nil in the post-intervention period (Table 4) showing the effectiveness of the intervention with RR-0.13(95% CI 0.05-0.31).

SSI in clean surgeries decreased from 93.8% (46/49) in the intervention period to 6.1% (3/49) in the post intervention period. Similarly SSI in clean contaminated surgeries decreased from 92.8% (52/56) to 10.7% (6/56) (Table 5), showing the effectiveness of intervention.

The use of urinary catheters in wards (catheter days) increased significantly from 39.8% (1,558/3912) to 60% (2354/3912) in the post-intervention period. However, CAUTI dropped significantly from 100% in the intervention period to nil in the post-intervention period (Table 6), showing the effectiveness of the intervention.

The central line catheter days increased from 49% (196/398) in the intervention period to 50.8% (202/398) in the post-intervention period, though CLABSI was not detected in any of the patients in both the periods (Table 7).

Hand hygiene compliance among Doctors, Nurses, ward boys, house keeping staffs and technicians was 100% during the intervention period in ICU and the general wards (Table 8). Overall, hand hygiene compliance among the health- care workers was maintained at 100% during both the periods.

The number of IV cannula audited in the intervention period was 57.3% (1342/2341) and in post intervention period, 42.7% (999/2341). The number of undated IV cannula decreased from 99% (116/117) in the intervention period to 0.85% (1/117) in the post intervention period.

Table 1: Trends in the reduction of HAI

Month &Year	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022	Total
HAI	89 (40%)	34 (15%)	26 (12%)	23 (10%)	13(6%)	13 (6%)	10 (5%)	6 (3%)	6 (3%)	0 (0%)	2 (1%)	222 (100%)

Table 2: Effect of the multifaceted intervention on the incidence of CAUTI in ICU patients.

Month & Year	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022	Total
Total no of ICU patients	123 (5.3%)	149 (6.4%)	199 (8.5%)	293 (13%)	279 (12%)	304 (13%)	136 (6%)	234 (10%)	231 (9.9%)	274 (11.7%)	120(5%)	2,342 (100%)
Total no with catheter	102 (7.7%)	112 (8.4%)	133 (10%)	149 (11%)	163 (12%)	149 (11%)	73 (5.5%)	137 (10%)	123 (9%)	132 (9.9%)	57(4.3%)	1,330 (100%)
No of catheter days	387 (8%)	426 (9%)	501 (10.6%)	510 (11%)	470 (10%)	568 (12%)	275 (5.8%)	529 (11%)	385 (8%)	459 (9.7%)	210(4.4%)	4,720 (100%)
No. of cultures sent	51 (16%)	40 (12%)	46 (14%)	22 (6.8%)	35 (11%)	41 (13%0	17 (5.3%)	23 (7%)	19 (6%)	18 (5.6%)	10 (3%)	322 (100%)
Isolates	20 (27%)	11 (15%)	11 (15%)	7 (9%)	6 (8%)	9 (12%)	5 (7%)	2 (3%)	2 (3%)	0	2 (3%)	75 (100%)
CAUTI	15 (32%)	10 (21%)	7 (15%)	6 (13%)	1 (2%)	1(2%)	2 (4.3%)	1 (2%)	2 (4.3%)	0	2 (4.3%)	47 (100%)
Colonizer	2 (18%)	3 (27%)	1 (9%)	0	3 (27%)	2 (18%)	0	0	0	0	0	11 (100%)
Community aquired	4 (14%)	8 (28%)	6 (21)	7 (25%)	2 (7%)	1 (4%)	0	0	0	0	0	28 (100%)

Table 3: Effect of the multifaceted intervention on the incidence of CLABSI in ICU patients.

Month & Year	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022	Total
Total no of ICU patients	123 (5.3%)	149 (6.4%)	199 (8.5%)	293 (13%)	279 (12%)	304 (13%)	136 (6%)	234 (10%)	231 (9.9%)	274 (12%)	120 (5%)	2,342 (100%)
Total no of Cental line patients	21 (5.4%)	18 (5%)	23 (6%)	46 (12%)	42 (11%)	41 (10.%)	30 (7.8%)	34 (8.8%)	40 (10%)	71 (18%)	22 (5.7%)	388 (100%)
No of Central line day	97 (7.8%)	151 (12%)	88 (7%)	168 (14%)	211 (17%)	87 (7%)	117 (9%)	68 (6%)	67 (5.4%)	75 (6%)	105 (8.5%)	1,234 (100%)
No. o f cultures sent	8 (27%)	5 (17%)	4 (13%)	3 (10%)	1(3%)	1 (3%)	1 (3%)	1 (3%)	2 (7%)	4 (13%)	0	30 (100%)
CLABSI	8 (31%)	5 (19%)	4 (15%)	3 (12%)	1 (4%)	1 (4%)	1 (4%)	1 (4%)	2 (8%)	0	0	26 (100%)

Similarly the number of over dated IV cannula decreased from 95% (37/39) to 5% (2/39) in the post-intermention period.

The number of IV sets audited in the intervention period was 53.7% (962/1,791) and in post intervention period, 46.2% (829/1,791). The number of undated IV sets decreased from 97% (68/70) in the intervention period to 3% (2/70) in the post intervention period. Similarly the number of over dated IV sets decreased from 91.5% (43/47) to 8.5% (4/47) in the post intervention period.

The number of central lines audited in the intervention period was 66.6% (126/189) and in post intervention period, 33.3% (63/189). The number of undated central lines decreased from 100% (2/2) in the beginning of the intervention period to nil in the post intervention period

The number of Foley's catheter audited in the intervention period was 57.5% (337/586) and in post intervention period, 42.5% (249/586). The number of undated Foley's catheter decreased from 100% (43/43) in the intervention period to nil in the post intervention period

3.3. *Adjustment for potential confounding*

We performed a multi-variable analysis to adjust for factors that might be different between the two time periods, including factors that might reflect different disease

Table 4: Effect of the multifaceted intervention on the incidence of VAP in ICU

Month & Year	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022	Total
Total no of ICU patients	123 (5.3%)	149 (6.4%)	199 (8.5%)	293 (13%)	279 (12%)	304 (13%)	136 (6%)	234 (10%)	231 (9.9%)	274 (12%)	120 (5%)	2,342 (100%)
Total no of patients on ventilator	58 (6%)	47 (5%)	58 (6%)	149 (16%)	163 (17%)	149 (16%)	107 (11%)	68 (7%)	58 (6%)	71 (7.3%)	32 (3%)	960 (100%)
No of ventilator days	163 (6%)	136 (5%)	138 (5%)	510 (19%)	470 (17%)	568 (21%)	347 (13%)	140 (5%)	68 (2.5%)	75 (3%)	51 (2%)	2,666 (100%)
No. of ET culture send	17 (10%)	8 (5%)	13 (8%)	22 (13%)	35 (21%)	41 (25%)	18 (11%)	2 (1%)	3 (2%)	4 (2.5%)	0	163 (100%)
No of isolates	17 (28%)	5 (8%)	8 (13%)	7 (12%)	6 (10%)	9 (15%)	5 (8%)	2 (3%)	1 (2%)	0	0	60 (100%)
No of HAI VAP	15 (45%)	5 (15%)	4 (12%)	3 (9%)	1 (3%)	1 (3%)	1 (3%)	2 (6%)	1 (3%)	0	0	33 (100%)
Community acquired VAP patients	10 (37%)	3 (11%)	7 (26%)	0	3 (11%)	2 (7%)	1 (4%)	1 (4%)	0	0	0	27 (100%)

Table 5: Effect of the multifaceted intervention on the incidence of SSI

Month & Year	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022	Total
Total no of surgeries	266 (5%)	438 (8%)	512 (9%)	682 (12%)	598 (11%)	625 (11%)	(7%) 553(10%)	396	191 (3.5%)	663 (12%)	600 (11%)	5,524 (100%)
SSI in Clean surgeries	19 (39%)	8 (16%)	6 (12%)	5 (10%)	4 (8%)	4 (8%)	2(4%)	1 (2%)	0	0	0	49 (100%)
SSI in Clean contaminated surgeries	25 (45%)	5 (9%)	4 (7%)	6 (11%)	6 (11%)	6 (11%)	4 (7%)	1 (1.8%)	1 (1.8%)	0	0	56 (100%)

Table 6: Effect of the multifaceted intervention on the incidence of CAUTI in WARD patients.

Month & Year	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022	Total
Total no. of patients with catheter	65 (5%)	70 (5%)	69 (5%)	90 (7%)	79 (6%)	163 (12%)	237 (17%)	151(11%)	102 (7%)	233 (17%)	106 (8%)	1,365 (100%)
No of catheter days	150 (4%)	165 (4%)	173 (4.4%)	368 (9%)	248 (6.3%)	454 (12%)	643 (16%)	462(12%)	250 (6.4%)	635 (16%)	364 (9.2%)	3,912 (100%)
CAUTI	7 (78%)	1 (11%)	1 (11%)	0	0	0	0	0	0	0	0	9 (100%)
Colonizer	0	0	0	0	0	0	0	0	0	0	0	0

Table 7: Effect of the multifaceted intervention on the incidence of CLABSI in WARD patients.

Month & Year	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022	Total
Total no of Central line patients	2 (6%)	5 (15%)	0	3 (9%)	0	0	5 (15%)	4 (12%)	3 (9%)	6 (18%)	5 (15%)	33 (100%)
No of central line days	55 (14%)	106 (27%)	0	35 (9%)	0	0	58 (14.5%)	60 (15%)	21 (5%)	38 (10%)	25 (6%)	398 (100%)
CLABSI	0	0	0	0	0	0	0	0	0	0	0	0

Table 8: Hand hygiene compliance

Month & Year	No. of doctors	No.of nurses	No.of ward boys and house keeping staff	No. of technicians	No.of opportunities	Missed opportunites	Compliance (%)
Jun 2021	520 (8%)	870 (8%)	333 (7%)	70 (4.6%)	1793 (7.6%)	0	100
Jul 2021	544 (8.4%)	865 (8%)	453(9.7%)	88 (5.7%)	1950 (8.3%)	0	100
Aug 2021	588 (9%)	984 (9%)	321 (7%)	96 (6.3%)	1989 (8.5%)	0	100
Sep 2021	555 (8.6%)	854 (8%)	328 (7%)	110 (7.2%)	1847 (7.9%)	0	100
Oct 2021	540 (8.4%)	792 (7%)	418 (9%)	178 (11.6%)	1928 (8.2%)	0	100
Nov 2021	657 (10%)	890 (8%)	469 (10%)	150 (9.8%)	2166 (9.2%)	0	100
Dec 2021	672 (10.4%)	817 (8%)	352 (7.5%)	114 (7.4%)	1955 (8.3%)	1	99.95
Jan 2022	323 (5%)	678 (6.3%)	323 (7%)	124 (8%)	1448 (6.2%)	0	100
Feb 2022	1059 (16.4%)	1925 (17.8%)	920 (19.6%)	288 (18.8%)	4192 (17.8%)	0	100
Mar 2022	538 (8.3%)	1110 (10.3%)	401 (8.6%)	178 (11.6%)	2227 (9.5%)	0	100
Apr 2022	468 (7.2%)	1022 (9.5%)	365 (8%)	137 (9%)	1992 (8.5%)	0	100
Total	6,464 (100%)	10,807 (100%)	4,683 (100%)	1,533 (100%)	23,487 (100%)	1 (100%)	100

Table 9: Device audit details

Month & Year	No. of IV cannula audited	Undated IV cannula	Over dated IV cannula	No. of IV set audited	Undated IV sets	Over dated IV sets	No.of Central line audited	Undated Central line	No.of Foley's catheter	Undated Foley's catheter
Jun 2021	220 (9.4%)	20 (17%)	9 (23%)	130 (7.3%)	14 (20%)	8 (17%)	22 (11.6%)	2 (100%)	55 (9.4%)	9 (21%)
Jul 2021	231 (9.9%)	18 (15.4%)	6 (15.4%)	140 (7.8%)	11 (15.7%)	9 (19%)	18 (9.5%)	0	60 (10%)	8 (18.6%)
Aug 2021	222 (9.5%)	16 (13.7%)	8 (20.5%)	155 (8.7%)	13 (18.6%)	7 (14.9%)	25 (13.2%)	0	52 (8.9%)	7(16.3%)
Sep 2021	214 (9%)	19 (16.2%)	4 (10.3%)	162 (9%)	11 (15.7%)	6 (12.8%)	24 (12.7%)	0	56 (9.6%)	6 (14%)
Oct 2021	217 (9.3%)	21 (18%)	7 (18%)	198 (11%)	12 (17%)	9 (19%)	26 (13.8%)	0	58 (9.9%)	7 (16.3%)
Nov 2021	238 (10%)	22 (18.8%)	3 (7.7%)	177 (9.9%)	7 (10%)	4 (8.5%)	11 (5.8%)	0	56 (9.6%)	6 (14%)
Dec 2021	246 (10.5%)	0	0	219 (12%)	0	0	19 (10%)	0	70 (12%)	0
Jan 2022	201 (8.6%)	0	0	158 (8.8%)	0	0	12 (6.3%)	0	54 (9.2%)	0
Feb 2022	209 (8.9%)	1 (0.85%)	1 (2.6%)	142 (7.9%)	1 (1.4%)	2 (4.3%)	13 (6.9%)	0	38 (6.5%)	0
Mar 2022	205 (8.8%)	0	1 (2.6%)	168 (9.4%)	1 (1.4%)	2 (4.3%)	13 (6.9%)	0	46 (7.9%)	0
Apr 2022	138 (5.9%)	0	0	142 (7.9%)	0	0	6 (3.2%)	0	41 (7%)	0
Total	2,341 (100%)	117 (100%)	39 (100%)	1,791 (100%)	70 (100%)	47 (100%)	189 (100%)	2 (100%)	586 (100%)	43 (100%)

severity among patients or which might interact with the intervention. We adjusted for patient characteristics, independent risk factors of HAI and independent risk factors of mortality derived from this study. After adjusting with those factors, we found that none of those patient characteristics, independent risk factors for HAI or independent risk factors of mortality significantly changed the effect of the multifaceted intervention in reducing HAIs in the post-intervention period: adjusted OR 0.28 (95% CI 0.21 to 0.38) (p<0.001)

3.4. The effectiveness of a multifaceted intervention on irrational antibiotic use

The overall use of antibiotics in the ICUs decreased from intervention to post-intervention periods; these were prescribed for 58% (780/1347) and 44% (442/995) of all patients in the ICUs, respectively (RR 0.44 (0.40 to 0.55) (p=0.43).

4. Discussion

HAIs are a universal healthcare problem. The largest burden is in developing countries where surveillance is rarely performed and intervention research is limited. However, it is in these settings where basic infection control interventions may have the greatest impact.

Infection control programme should integrate two fundamental strategies in order to reduce HAIs: reducing transmission of pathogens between patients and reducing the emergence and spread of antibiotic resistance. Despite financial constraints in settings with limited resources, we have shown that simple infection control measures, principally, hand hygiene and the more rational use of antibiotics, are feasible and effective. To our knowledge, this is the first quality improvement study that has evaluated the effectiveness of an infection control and antibiotic stewardship programme among hospitalized patients in a tertiary care hospital in southern India.

Patients in the intervention and post-intervention periods of this study had similar characteristics, including gender, age and underlying diseases, and could be expected to have similar intrinsic infection risks in both periods. However, there are a number of other sources of potential bias in any before-and-after study, including ascertainment bias. We addressed this in several ways. First, there was no difference in the proportion of cultures collected when patients had signs and symptoms of infection between the two time periods (data not shown). Second, there were no changes to laboratory procedures between the intervention and post-intervention periods that might lead to more false-positive cultures in the intervention period, or false-negative cultures in the post-intervention period.

Adjustment for characteristics of the patient populations was done to make a reliable estimation of the effect of the intervention and reduce confounding.[16–18] Such differences included patient demographic and illness severity characteristics, intrinsic infection risk factors and other risks and treatment differences.[17,18] None of these significantly changed the effectiveness of the intervention for reducing HAIs; the impact of such an intervention on decreasing the rates of HAIs was greater than 75%.

Previous studies involving hand hygiene campaigns to reduce HAIs in developing countries provided effect sizes ranging from 12.7% to 100%.[19] However, those studies were mostly undertaken in neonates and adults. Two previous developing country studies involving adult populations were solely in ICUs.[20,21]

The number of patients developing HAI decreased from 89% (198/222) in the intervention period to 10.8% (24/222) in the post-intervention period (relative risk (RR) (95% CI) 0.48 (0.31 to 0.56). The most common causes of HAIs in both periods were Gram-negative bacteria. A similar finding was also observed in the previous review conducted in developing countries.[1] Hand hygiene has been shown to be effective in preventing transmission of Gram-negative bacteria.[22,23]

Hand hygiene is inexpensive and fundamental to infection prevention programme, and our data provide strong evidence of its value in developing countries. Overall, hand hygiene compliance among the health-care workers was maintained at 100% during both the periods, which is more than of other studies with post-intervention hand hygiene compliance rates reported between 40% and 60%.[24,25]

The overall use of antibiotics in the ICUs decreased from intervention to post-intervention periods; these were prescribed for 58% (780/1347) and 44% (442/995) of all patients in the ICUs, respectively (p=0.43). More rational prescribing was achieved, particularly, de-escalation of antibiotics. In a developing country, referral hospitals where infectious diseases remain the major cause of hospital admissions and where bacterial infection rates are high, antibiotic prescribing at this level is understandable. The greatest gains in reducing antibiotic prescribing may not be in limiting the initiation of antibiotic treatment, but in earlier cessation or scaling down when serious bacterial infection is unlikely.[26]

Inappropriate use of antibiotics is a universal problem. It has been described well in developed countries, but a renewed focus is needed in developing countries, where the major burden of antibiotic resistance may exist.[26]

Although the multifaceted intervention was not primarily aimed at reducing overall hospital mortality, we observed a significant reduction in deaths. After adjustment for several high- risk patient characteristics, types of treatments and the severity of illness, the multifaceted intervention was associated with a risk of in-hospital mortality that was at least 6% lower in the post-intervention period.

While it is difficult to isolate the most effective components of the intervention we used, such an effectiveness study reflects the complexity of clinical practice.[27] A before-and-after study design is a practical choice for the evaluation of the effective- ness of a complex quality improvement intervention, and it is commonly used for implementation of best practice guidelines when a randomized controlled trial is not feasible or ethical. The 11-month period before and after the intervention was chosen so as to reduce any effect of seasonal variation of HAIs[27] or other infections, and an identical method of data collection before and after the intervention was used to minimise bias.[27]

5. Conclusions

A multifaceted infection control and antibiotic stewardship programme were effective in reducing HAIs and improving healthcare outcomes, including reducing in-hospital mortality. Even in resource-limited settings, HAIs and their consequences are not inevitable events.

6. Conflict of Interest

The authors declare no relevant conflicts of interest.

7. Source of Funding

None.

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Cite this article: Kothapalli MB, Narayanaswamy G, Rani L, Maheshwar U, Babu R, Paruchuri S, Karpuranath S, Mishra R, Alapaty S. Reducing hospital-acquired infections and improving the rational use of antibiotics in a tertiary care hospital in Bangalore. *IP Int J Med Microbiol Trop Dis* 2022;8(3):210-218.