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Review

Positive deviance in infection prevention and control: A systematic literature review

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Abstract

Background: Healthcare-associated infections (HAIs) remain a major challenge. Various strategies have been tried to prevent or control HAIs. Positive deviance, a strategy that has been used in the last decade, is based on the observation that a few at-risk individuals follow uncommon, useful practices and that, consequently, they experience better outcomes than their peers who share similar risks. We performed a systematic literature review to measure the impact of positive deviance in controlling HAIs.

Methods: A systematic search strategy was used to search PubMed, CINAHL, Scopus, and Embase through May 2020 for studies evaluating positive deviance as a single intervention or as part of an initiative to prevent or control healthcare-associated infections. The risk of bias was evaluated using the Downs and Black score.

Results: Of 542 articles potentially eligible for review, 14 articles were included for further analysis. All studies were observational, quasi-experimental (before-and-after intervention) studies. Hand hygiene was the outcome in 8 studies (57%), and an improvement was observed in association with implementation of positive deviance as a single intervention in all of them. Overall HAI rates were measured in 5 studies (36%), and positive deviance was associated with an observed reduction in 4 (80%) of them. Methicillin-resistant *Staphylococcus aureus* infections were evaluated in 5 studies (36%), and positive deviance containing bundles were successful in all of them.

Conclusions: Positive deviance may be an effective strategy to improve hand hygiene and control HAIs. Further studies are needed to confirm this effect.

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Background

Healthcare-associated infections (HAIs) remain a major challenge[1,2]; they are associated with increased morbidity and mortality.[3] The total annual cost for the major HAIs is ~$10 billion in the United States.[4] In the last few decades, various strategies have been tried to prevent or control HAIs.[5] National collaboratives of HAI programs have recognized many social and adaptive challenges encountered by participants.[6]

The Positive Deviance Collaborative notes, “Positive deviance is based on the observation that in every community there are certain individuals or groups whose uncommon behaviors 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.”[9] This technique has been used since the 1960s in vulnerable communities to enhance the best practices for problems such as genital mutilation, malnutrition, education, contraception, and vaccinations, and more recently for HAI prevention and control.[10–14]

In positive deviance, changes start at the bottom of a particular community then spread upward with initial permission from leadership.[13] For example, employees of a particular organization would be screened looking for a positive deviant, for example, someone good at performing hand hygiene. After a specific period of positive deviance implementation, those positive deviants recruit others through regular meetings and discussions in a just culture with leadership presence.[15] A social network starts to form that can be analyzed for collaboration enhancement.[16]

Positive deviance has been used in many infection prevention initiatives. Although the change occurs “from the bottom,” positive deviance interventions specifically aim to find and empower positive deviants. Positive deviance was included in the methicillin-resistant *Staphylococcus aureus* (MRSA) initiative (ie, MRSA bundle) at the US Department of Veterans’ Affairs (VA) medical centers in August 2006 after a successful pilot study. It was included as a modality for encouraging culture change.[17]

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Our systematic literature review evaluates the existing evidence for using positive deviance to improve and enhance practices such as hand hygiene to prevent and control HAIs.

Methods

Systematic review and inclusion and exclusion criteria

This review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement.[18] This study was registered on Prospero on November 5, 2019 (https://www.crd.york.ac.uk/PROSPERO/, registration no. CRD42019137784). Institutional review board approval was not required. We included studies that met the following criteria: original quantitative research manuscripts; published in peer-reviewed, scientific journals; involved human inpatients; and conducted in hospital settings that evaluated positive deviance as a single intervention or part of an initiative as a strategy to prevent or control HAIs. The literature search was conducted from database inception to May 31, 2020. There were no language restrictions. Qualitative studies, editorials, and commentaries were excluded.

Search strategy

The search strategies were developed in collaboration with a health sciences librarian (R.J.S.) trained in systematic review searching. The search focused on finding studies evaluating positive deviance as a single intervention or as part of an initiative to prevent or control healthcare-associated infections.

Using subject headings and keywords, systematic search strategies were created for PubMed, Embase (Elsevier), CINAHL (EBSCO), and Scopus (Elsevier). Search terms included subject headings (when available) and key words for the following terms: positive deviance, infection, infection control, epidemiology, communicable disease control, hand hygiene, hand washing, cross-infection, healthcare-associated infection, hospital infection, and nosocomial infection. The searches were conducted in May 2020, and no search filters (including date range) were used during the search process. All identified studies were combined into a citation management program (EndNote), and duplicates were identified and discarded. The detailed search strategies can be reviewed in Appendix 1 (online).

Data abstraction and quality assessment

Titles and abstracts of all articles were screened to assess whether they met inclusion criteria. The reviewers (M.A.A.[1], A.R.M., and M.A.A.[2]) retrieved data on study design, population and setting, and the positive deviance intervention definition using paper-based forms. We also collected information about the year of intervention, study design (quasi-experimental, case-control, cohort study, or randomized clinical trial), positive deviance interventions (definition and single or part of an initiative), HAI intervention (HAIs interventions overall, and specifically hand hygiene [HH] and MRSA prevention), type of infection, and the outcome measures.

We used the scale employed by Downs and Black[19] to evaluate study quality. This tool is a checklist that has 27 items regarding reporting, external validity, bias, confounding, and power, with items scored 0–1 (except for 1 item in the reporting subscale, which is scored 0–2), where 1 is "yes" and 0 is "no" or "unable to determine." Each reviewed paper was assessed, and the total score was calculated. We used all the questions as written except for question #27 (a single item on the power subscale, which was scored 0–5), which we changed to a yes/no answer. The score for each article was categorized as "excellent" (24–28 points), "good" (19–23 points), "fair" (14–18 points), or "poor" (<14 points).[20] The authors (M.A., A.R.M., and M.A.A.) performed component quality analyses independently and reviewed all inconsistent assessments. When divergent opinions arose, consensus was achieved by discussion.[21]

Results

Characteristics of included studies

Of 38 full-text articles potentially eligible for full review (Fig. 1), 14 articles met the inclusion criteria and were included in the systematic review (Table 1).[22–35] All studies were observational, quasi-experimental (before-and-after intervention) studies.[22–35] Of the 11 studies that reported the type of healthcare setting,[22–26,29–32,34,35] 3 studies (27%) had at least 1 academic medical center included.[30,32,35] A quarter of the studies (3 of 11, 27%) were conducted in the Veterans' Affairs (VA) Health Care System.[22,24,25] Few studies (3 of 12, 25%) were multicenter[25,27,32]; the number of involved centers was 165 (range, 5–153 per study).[22–35] The United States (6 of 14, 43%) and Brazil (4 of 14, 29%) had the most studies among the 6 countries represented. Only 2 studies were published after 2015.[34,35] The median duration of an intervention was 28 months (range, 9–144 months).[22–35]

Regarding the quality assessment of included studies, 4 studies (4 of 14, 29%) scored poorly (<14 of 28 possible),[27,28,30,33] whereas 3 studies (21%) scored between 19 and 23 (good).[16,32,35] The median score was 16 (range, 2–22). The median score for the internal validity section of the Downs and Black tool was only was only 7 of 13, while the median score for the external validity section was 3 out of 3 for the included studies. We did not observe any changes in the efficacy of the intervention in comparison to the quality of the article.

Outcome measures

Hand hygiene

Most of the studies that evaluated the effect of positive deviance on HH implemented it as a single intervention (6 of 8, 75%).[23,26,29,30,32,33] All of these noted that there was an improvement in HH compliance by direct observation or indirect measures (calculating product usage, or by electronic monitoring of sink or alcohol gel dispenser use),[37,38] yet the results of only 2 studies achieved statistical significance.[16,32] Half of the studies (4 of 8) mentioned direct HH observation differences or rates.[27,28,30,33] Although the other 4 studies (4 of 8, 50%) mentioned indirect HH measures (eg, alcohol hand gel use), the number of aliquots of alcohol gel dispensed per 1,000 patient days, and chlorhexidine used electronically.[16,32,36,39]

Marra et al[23] (2010) found a significant increase in the use of alcohol gel from 136 to 249.5 L per 1,000 patient days ($P < .01$) in an intervention unit where positive deviance was used as a single intervention to enhance HH when compared to a control unit.[23] In another study in 2011, Marra et al[26] reported a 4-fold increase in the use of alcohol hand gel after introducing positive deviance.

From the Canadian positive deviance project, Reason et al[27] reported that HH compliance increased by 53%. Crump et al[28] also reported that HH compliance increased by >30% through a bundle that included positive deviance. Gitterman et al[30] reported a >2-fold increase in HH compliance in a multicenter study from 2008 to 2013.

In 2012, Macedo et al[29] reported that the ratio of alcohol hand rub use to nurse visits increased from 1 to >2.5 in 2 units after implementing positive deviance. In 2013, Marra et al[32] confirmed

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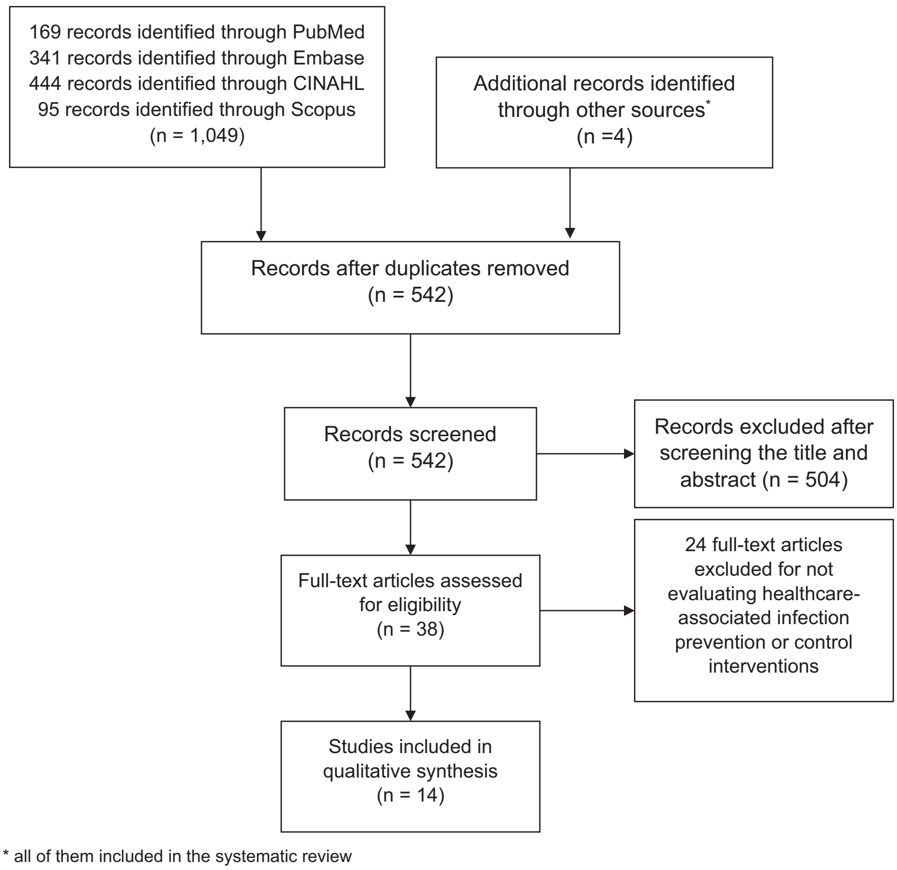

Fig. 1. Literature search for articles on positive deviance in infection prevention and control.

in a multicenter study that HH compliance improved by direct observation (46.5 to 62.0%; $P < .001$) and indirectly by the alcohol hand gel usage (42.3 to 72.0 L per 1,000 patient days; $P < .05$).

Bren et al[33] found mean HH compliance to be 72% prior to a positive deviance intervention, with a gain of 7% in 18 months with increased HH awareness due to positive deviance (Table 1).

HAI general incidence

In studies that reported overall HAI rates, positive deviance was used as a single intervention.[23,26,29,32,35] In 2010, Marra et al[23] found an observed reduction in HAI incidence density (9.4 to 6.5 infections per 1,000 patient days in a positive deviance intervention unit vs 8.9 to 12.7 in a control unit, $P < .05$). In 2011, Marra et al[26] again reported a decrease in HAI incidence density in 2 units (16.2 to 11.0 and 15.1 to 10.3 per 1,000 patient days; $P < .05$) following a positive deviance intervention between 2007 and 2009.

Macedo et al[29] found that HAI incidence density trended downward in 2 units (9.8 to 7.2 and 6.3 to 4.4 per 1,000 patient days; *P*, nonsignificant).[29] From Brazil and Thailand in 2013, Marra et al[32] reported no significant difference in positive deviance before and after an intervention to reduce HAI incidence density.[32]

In 2018, Sreeramoju et al[35] evaluated positive deviance with randomly selected units and found no significant difference between intervention and control units, but both experienced a statistically significant decrease in the rate of HAIs over time after implementing positive deviance.

BSI incidence

All studies reporting overall BSI incidence used positive deviance as a single intervention,[23,26,29,32] and 1 study reported access-related BSIs in hemodialysis centers.[31] In 2011, Marra et al[26] reported a reduction in the BSI in 1 of 2 units that were studied (2.5 to 1.7 and 0.7 to 0.9 per 1,000 catheter days; *P*, nonsignificant). Macedo et al[29] reported a trend toward reduction, but the changes were not statistically significant. In 2013, Marra et al[32] found a decrease in BSI (1.6 to 0.0 per 1,000 catheter days; *P* nonsignificant) in 7 participating centers.

In 2013, Lindberg et al[31] evaluated the effect of positive deviance on BSI in hemodialysis patients. They found a statistically significant reduction in access-related BSIs (2.04–0.24 per 100 patient months; $P < .01$).[31]

MRSA prevention

Positive deviance was used as part of the initiative in 4 studies (4 of 6, 67%) that reported on MRSA-related HAIs.[22,24,25,28] Awad et al[22] reported a reduction in MRSA-related HAIs (2.0 to 1.0 per 1,000 bed days; $P < .05$). In 2011, Ellingson et al[24] found a decrease in hospital-wide MRSA infection or colonization (2.40 to 1.88 per 1,000 patients days; $P < .01$).

From the largest study of positive deviance, a Veterans' Affairs initiative, Jain et al[25] reported a significant reduction in MRSA-related HAIs (1.64 to 0.62 per 1,000 patient days; $P < .001$ for trend) in intensive care units (ICU), a decline in the rate of MRSA BSI not related to a device (0.16 to 0.06 per 1,000 patient days; $P < .001$ for trend), and a decline in the rate of MRSA device-related BSIs (0.14 to 0.03 per 1,000 patient days; $P < .001$ for trend). In the same study, there was also a reduction in MRSA-related HAIs in non-ICUs (0.47 to 0.26 per 1,000 patient days; $P < .001$ for trend) and for MRSA BSI (0.12 to 0.05 per 1,000 patient days; $P = .11$).[25]

From Colombia, Escobar et al[34] noted a reduction in MRSA-related HAIs across a single hospital (4.43 to 2.69 per 1,000 patient

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Table 1. Summary of Characteristics of Studies Included in the Systematic Review (n=14)

First Author, Year, Place	Year(s) of Study (Months)	Setting (No. of Hospitals)	Positive Deviance Defined	Single Intervention or Part of an Initiative	Measured Metrics[a]	Outcome	D&B Score
Awad, 2009, TX, US[22]	2005–2008 (36)	VA (1)	No	Part of an initiative	MRSA prevention	Reduction observed in MRSA related infections: MRSA HAI, from 2.0 to 1.0 per 1,000 bed days[b] MRSA BSI, from 2.9 to 2.5 per 1,000 bed-days	15
Bren, 2015, ND, US[33]	NR (18)	NR (1)	Yes	Single	Hand hygiene CDI prevention	Hand hygiene improved by 7% CDI, 0 for 18 months	10
Crump, 2012, Canada[28]	Since Oct 2009 (NR)	NR	No	Part of an initiative	Hand hygiene MRSA prevention CDI prevention	Hand hygiene increased by 30% MRSA rate decreased by 64% CDI rate decreased by 41%	2
Ellingson, 2011, PA, US[24]	1999–2008 (108)	VA (1)	No	Part of an initiative	MRSA prevention	Reduction observed in MRSA related infections: Hospital wide from 2.40 to 1.88 per 1,000 patient days[b]	16
Escobar, 2017, Bogotá, Columbia[34]	2001–2012 (144)	Comm. (1)	Yes	Single	MRSA prevention	Reduction observed in MRSA related infections: MRSA HAI (all-hospital), from 0.62 to 0.36 per 1,000 patient days[b] MRSA HAI (ICU) *S. aureus* infection, from 8.16 to 5.97 per 1,000 patient days[b]	18
Gitterman, 2013, UHN, Canada[30]	2008–2012 (48)	AMC (NR)	Yes	Single	Hand hygiene MRSA prevention CDI prevention	Hand hygiene, from 41% to 88% MRSA, from 0.41 to 0.33 per 1,000 patient days CDI, from 0.58 to 0.46 per 1,000 patient days	9
Jain, 2011, Pittsburgh, PA, US[25]	2007–2010 (33)	VA (153)	No	Part of an initiative	MRSA prevention	In ICU: reduction observed HAI, from 1.64 to 0.62 per 1,000 patient days[b] BSI (non–line related), from 0.14 to 0.03 per 1,000 patient days[b] BSI (line related), from 0.16 to 0.06 per 1,000 patient days[b] Pneumonia (non–device related), from 0.35 to 0.22 per 1,000 patient days[b] Pneumonia (device related), from 0.32 to 0.08 per 1,000 patient days[b] UTI, from 0.16 to 0.04 per 1,000 patient days[b] SSTI, from 0.16 to 0.04 per 1,000 patient days[b] In non-ICU: reduction observed HAI, from 0.47 to 0.26 per 1,000 patient days[b] BSI, from 0.12 to 0.05 per 1,000 patient days[b] Pneumonia, from 0.08 to 0.05 per 1,000 patient days[b] UTI, from 0.09 to 0.05 per 1,000 patient days SSTI, from 0.15 to 0.07 per 1,000 patient days[b]	16
Lindberg, 2013, NJ, US[31]	2008–2011 (48)	Comm. (1)	Yes	Single	BSI prevention	Reduction observed in Access related BSI: All-access BSI, from 2.04 to 0.24 per 100 patient months[b] Access related BSI among catheter patients, from 2.07 to 1.32 per 100 patient months	17
Macedo, 2012, São Paulo, Brazil[29]	2008–2010 (28)	Comm. (1)	Yes	Single	Hand hygiene HAI prevention	Hand hygiene: improved Alcohol hand rub uses, nurse visits ratio was >2.5 in unit 1 and unit 2 HAI: reduction observed Incidence density of HAI, in unit 1 from 9.8 to 7.2 and unit 2 from 6.3 to 4.4 per 1,000 patient days[b] ABSI, in unit 1 from 2.7 to 1.1 and unit 2 from 1.7 to 1.9 per 1,000 catheter days Device associated infection, in unit 1 from 1.2 to 0.2[b] and unit 2 from 2.0 to 1.2 per 1,000 patient days Pneumonia, in unit 1 from 3.4 to 0.6 and unit 2 from 2.0 to 0 per 1,000 tracheostomy days UTI, in unit 1 from 16.6 to 4.4 and unit 2 from 8.9 to 6.3 per 1,000 catheter days[b]	16

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Marra, 2010, São Paulo, Brazil[23]	2008 (9)	Comm. (1)	Yes	Single	Hand hygiene HAI prevention	Hand hygiene: improved Alcohol gel used, in unit 1 from 136.0 to 238.8[b] and unit 2 from 115.1 to 204.8 per 1,000 patient days HAI: reduction observed Incidence density of HAI in unit 1 from 9.4 to 7.3 and unit 2 from 8.9 to 5.4 per 1,000 patient days BSI in unit 1 from 3.3 to 0 and unit 2 from 0 to 0 per 1,000 catheter days Device associated infections in unit 1 from 4.0 to 2.4 and unit 2 from 3.3 to 2.1 per 1,000 patient days	19
Marra, 2011, São Paulo, Brazil[26]	2008–2009 (21)	Comm. (1)	Yes	Single	Hand hygiene HAI prevention	Hand hygiene: improved Alcohol gel used, a 4-fold difference HAI: reduction observed Incidence density of HAI in unit 1 from 16.2 to 11.0 and in unit 2 from 15.1 to 10.3 per 1,000 patient days[b] BSI in unit 1 from 2.5 to 1.7 and in unit 2 from 0.7 to 0.9 per 1,000 catheter days Device associated infection in unit 1 from 5.8 to 2.8 and in unit 2 from 3.7 to 1.7 per 1,000 patient days[b] Pneumonia, in unit 1 from 7.3 to 0.6 and unit 2 from 4.2 to 0.9 per 1,000 tracheostomy days[b]	10
Marra, 2013, Brazil and Thailand[32]	2011–2012 (12)	AMC, Comm. (7)	Yes	Single	Hand hygiene HAI prevention	Hand hygiene: improved Alcohol gel used from 42.3 to 72.0 per 1,000 patient days[b] HAI: reduction observed Device-associated infection from 13.2 to 7.5 per 1,000 patient days[b] BSI, from 1.6 to 0 per 1,000 catheter days Pneumonia, from 13.4 to 7.4 per 1,000 ventilator days UTI, from 1.7 to 0 per 1,000 catheter days	19
Reason, 2011, Canada[27]	2009–2010 (12)	NR (5)	No	Single	Hand hygiene HAI-ARO preven-tion CDI prevention	Hand hygiene compliance increased by 53.2% HA-AROs of 25%, 41.2%, and 63.9% in 3 sites. HA-MRSA decreased by 100% at 2 hospital sites HA-CDI decreased at 3 sites by 53%, 51.9%, and 23%	7
Sreeramoju, 2018, TX, US[35]	2011–2013 (24)	AMC (1)	Yes	Single	HAI prevention	HAI: In the control group: from 4.8 to 2.8 per 1,000 patient days In the intervention group: from 5.0 to 2.1 per 1,000 patient days	22

Note. VA, Veterans' Affairs hospital; AMC, academic medical center; comm., community hospital; MRSA, methicillin-resistant *Staphylococcus aureus*; HAI, healthcare-associated infections; BSI, bloodstream infections; UTI, urinary tract infection; SSTI, skin and soft-tissue infection; QE, quasi-experimental; ICU, intensive care unit; HA, healthcare associated; ARO, antibiotic-resistant organism; CDI, *Clostridioides difficile* infection;
[a]MRSA initiative components: universal nasal surveillance for MRSA colonization, contact precautions for patients who were carriers of MRSA, hand hygiene, and an institutional culture change whereby infection control became the responsibility of everyone who had contact with patients.
[b]Statistically significant ($P < .05$).

days; $P < .001$) and in ICUs (0.77 to 0.45 per 1,000 patient days; $P < .05$) using positive deviance a single intervention.[34]

Other specific HAI outcomes

In 2010, Marra et al[23] observed a nonsignificant reduction in device-associated infections in 2 units (4.0 to 2.4 and 3.3 to 2.1 per 1,000 patient days; *P* nonsignificant). In 2011, they found a statistically significant difference (5.8 to 2.8 and 3.7 to 1.7 per 1,000 patient days; $P < .05$).[26] Similar findings were reported by Macedo et al,[29] from 1.2 to 0.2 per 1,000 patient days ($P < .05$).[29] From a multicenter study in Brazil and Thailand in 2013, Marra et al[32] found a reduction in device-associated infection from 13.2 to 7.2 per 1,000 patient days; $P < .05$).[32]

In 2011, Jain et al[25] found a reduction in pneumonia in ICUs; the non–ventilator-associated rate dropped from 0.35 to 0.22 per 1,000 patient days ($P < .05$), and the ventilator-associated rate fell from 0.32 to 0.08 per 1,000 patient days ($P < .05$).[25] They noted a similar reduction in non-ICUs from 0.08 to 0.05 per 1,000 patient days ($P < .05$).[25] From Brazil in 2011, Marra et al[26] reported a decrease in pneumonia rates in 2 units (from 7.3 to 0.6 and 4.2 to 0.9 per 1,000 tracheostomy days; $P < .05$ for both).[26] Macedo et al[29] showed a decrease in 2 units in pneumonia rates (from 3.4 to 0.6 and 2.0 to 0.0 per 1,000 tracheostomy days; *P*, nonsignificant). Subsequently in 2013, Marra et al[32] showed a decline in pneumonia rates in a multicenter study (from 13.4 to 7.4 per 1,000 ventilator days; *P*, nonsignificant).

With regard to urinary tract infection (UTI), Jain et al[25] demonstrated a reduction in UTI in both the ICU (from 0.16 to 0.04 per 1,000 patient days; $P < .05$) and non-ICU settings (from 0.09 to 0.05 per 1,000 patient days; *P*, nonsignificant). In 2012, Macedo et al[29] reported a decrease in the UTI rate in 2 units (from 16.6 to 4.4 and from 8.9 to 6.3 per 1,000 catheter days; $P < .05$ for both). Other studies were not able to demonstrate any significant decreases in their rates.[23,26]

Discussion

Our systematic literature review showed a tendency toward the benefit of positive deviance to reduce healthcare-associated infections. The positive deviant assists the group in achieving goals through discussion, empowerment, and role modeling.[13] It reverses the flow of influence and authority, as the learning pyramid is not top-down but bottom-up with the front-line worker now occupying the top position.[14] The principles of diffusion of innovations are very useful to comprehend the spread of a new practice or change through an institution or a community.[40,41]

In this review, we found that positive deviance may help different institutions in different countries around the world to achieve improvements in infection prevention and control. Positive deviance is an innovative method that does not require a strong infrastructure and thus is useful in underdeveloped countries.[42,43]

For HH, when positive deviance was used as a single intervention, it improved the compliance rate by direct and indirect observation.[23,26,29,44] It is possible that positive deviance improved HH compliance by developing a sense of ownership among healthcare workers and by demonstrating that HH is the most important tool for decreasing HAIs.[36]

Regarding HAIs, a significant reduction in overall incidence was observed in many studies included in this review.[16,32,36,39] In the studies by Sreeramoju et al,[13,35,45] there was no difference between the randomly selected intervention units and control units, but there was an overall reduction in HAIs for both units combined after the positive deviance intervention, which could be explained by a contiguous effect of positive deviance once started in an institution.

The VA Health System started an MRSA reduction intervention in which positive deviance was used as a component of a VA infection prevention initiative.[25] This could be attributed to the other elements of the structured initiative like MRSA nasal screening with contact precautions and standardized hand hygiene, but positive deviance was a new addition at that point and it might have enhanced the other components of this initiative.

Our study has several limitations. First, all of the included studies were nonrandomized, before-and-after, quasi-experimental observational studies (14 studies), which are subject to multiple biases.[22–34] This design is the most common study design in the infection prevention literature[46] and is frequently used when it is not logistically feasible or ethical to conduct a randomized, controlled trial.[47] However, study quality regarding compliance rates, bias and confounding, and failure to adjust for confounders and confirm equivalency between before-and-after test groups is a limitation of this review. Thus, it does not allow us to draw stronger conclusions from this evidence.[48] Second, the effect of positive deviance cannot be limited to defined units or locations as the involved employees may share their success and enable positive effects in the nonintervention arm, as observed by Sreeramoju et al.[35] Third, some studies that used positive deviance as a part of a bundle did not define the exact process of positive deviance implementation, positive deviant recruitment process, and social networking analysis, which may limit the impact of these studies on the effect of positive deviance on HAI prevention and control. Lastly, we could not perform a meta-analysis for the measured metrics because there were no reported absolute numbers in some studies and different metrics were used in different units with a limited number of included studies.

In conclusion, our systematic review included the best available evidence to support the use of positive deviance as a promising social empowering tool to achieve improvements in infection prevention. Higher-quality studies are needed given the overall low quality of available data identified in this systematic review. We suggest that future studies carefully define the positive deviant initial and subsequent recruitment processes.[14] Those studies should show the initial and improved social networking and how that impacted and enabled front-line personnel.[15,49] positive deviance is particularly relevant in the context of COVID-19; resource constraints affect the implementation of infection prevention recommendations and individuals within healthcare facilities must generate local solutions to address shortages, uncertainty, and stress.

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Appendix 1. Detailed search strategies

PubMed

("positive deviance"[tw]) OR (positive[tw] AND devian*[tw]) AND ("infection"[MeSH Terms] OR infection*[tw] OR "Infection Control"[Mesh] OR Epidemiology[mesh] OR Epidemiology[tw] OR "Communicable Disease Control"[Mesh] OR "Communicable Disease Control"[tw] OR "Hand Hygiene" [Mesh] OR "hand hygiene"[tw] OR "Cross Infection"[Mesh] OR "Cross Infection" [tw] OR "Cross Infections" [tw] OR "Health Care Associated Infection" [tw] OR "Health Care Associated Infections" [tw] OR "Healthcare Associated Infection" [tw] OR "Healthcare Associated Infections" [tw] OR "Hospital Infection" [tw] OR "Hospital Infections" [tw] OR "Nosocomial Infection" [tw] OR "Nosocomial Infections" [tw])

Embase

('positive deviance' OR 'positive deviance':ab,ti (positive AND deviance) OR (positive AND devian*)) AND ('infection'/exp OR infection OR 'infection':ab,ti OR 'infections':ab,ti OR 'infection control'/exp OR 'infection control' OR 'epidemiology'/exp OR epidemiology OR 'communicable disease control'/exp OR 'communicable disease control' OR 'communicable disease control': ab,ti OR 'hand washing'/exp OR 'hand washing' OR 'hand washing':ab,ti OR 'hand hygiene':ab,ti OR 'cross infection'/exp OR 'cross infection' OR 'cross infection':ab,ti OR 'healthcare associated infection'/exp OR 'healthcare associated infection' OR 'healthcare associated infection':ab,ti OR 'health care associated infections':ab, ti OR 'health care associated infection':ab,ti OR 'hospital infection'/ exp OR 'hospital infection' OR 'hospital infections':ab,ti OR 'hospital infections':ab,ti OR 'nosocomial infection':ab,ti OR 'nosocomial infections':ab,ti)

CINAHL

(TI ("positive deviance") OR (positive AND devian*)) OR (AB ("positive deviance") OR (positive AND devian*)) AND (((MH "Infection+") OR (MH "Cross Infection+") OR (MH "Epidemiology+") OR (MH "Infection Control+") OR (MH "Handwashing+")) OR (TI (infection OR infection* OR Epidemiology OR "Communicable Disease Control" OR "hand hygiene" OR "Cross Infection" OR "Cross Infections" OR "Health Care Associated Infection" OR "Health Care Associated Infections" OR "Healthcare Associated Infection" OR "Healthcare Associated Infections" OR "Hospital Infection" OR "Hospital Infections" OR "Nosocomial Infection" OR "Nosocomial Infections")) OR (AB (infection OR infection* OR Epidemiology OR "Communicable Disease Control" OR "hand hygiene" OR "Cross Infection" OR "Cross Infections" OR "Health Care Associated Infection" OR "Health Care Associated Infections" OR "Healthcare Associated Infection" OR "Healthcare Associated Infections" OR "Hospital Infection" OR "Hospital Infections" OR "Nosocomial Infection" OR "Nosocomial Infections")))

SCOPUS

(TITLE-ABS-KEY (('positive AND deviance' OR (positive AND deviance) OR (positive AND devian*)))) AND ((((TITLE-ABS-KEY ((infection) OR ('infection AND control') OR (epidemiology) OR ('communicable AND disease AND control') OR ('hand AND washing') OR ('hand AND hygiene') OR ('cross AND infection') OR ('cross AND infections') OR ('healthcare AND associated AND infection') OR ('healthcare AND associated AND infections') AND ('health AND care AND associated AND infection') AND ('health AND care AND associated AND infections') OR ('hospital AND infection') OR ('hospital AND infections') OR ('nosocomial AND infection') OR ('nosocomial AND infections')))) OR (INDEXTERMS ("infection" OR "infection control" OR "epidemiology" OR "communicable disease control" OR "hand washing" OR "cross infection" OR "healthcare associated infection" OR "hospital infection"))))

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