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**Lack of effect of a poster-based intervention to reduce the number of blood culture
samples collected**

**Manque d'efficacité d'une intervention basée sur un poster pour réduire le nombre de
prélèvements d'hémocultures**

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Contribution of authors

LB collected and processed the data from the hospital database, participated in the statistical analyses, and wrote the article.

TV and AG helped with the methodology and statistical analyses.

AV and ML participated in the implementation of the study: sending emails recalling guidelines to all wards, creating the poster, participating in information meetings, posting posters in the wards of the intervention group.

SB and NF recalled guidelines on blood culture collection at information meetings. They participated in the creation of the poster.

VM wrote the protocol of the study and participated in the implementation of the intervention, the poster, and the information meetings, and helped write the article.

NSB helped in editing the article.

DD and HD helped in extracting data from the hospital database.

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Keywords: blood culture, bacteremia, healthcare quality

Abstract

Objective. To reduce the number of blood culture samples collected.

Patients and method. We performed a cluster randomized controlled trial in adult acute care, and subacute care and rehabilitation wards in a university hospital in France. A poster associating an image of eyes looking at the reader with a summary of blood culture sampling guidelines was displayed in hospital wards in the intervention group. The incidence rate of blood cultures per 1,000 days during pre- and post-intervention periods was calculated.

Results. 31 wards participated in the study. The median difference in blood cultures/1,000 days between periods was -1.863 [-11.941; 1.007] in the intervention group and -5.824 [-14.763; -2.217] in the control group ($p=0.27$).

Conclusion. The intervention did not show the expected effect, possibly due to the choice of blood cultures as a target of good practice, but also to confounding factors such as the stringent policy of decreasing unnecessary costly testing.

INTRODUCTION

International guidelines [1] recommend collecting two samples of blood cultures (BC) [2–4] to detect bloodstream infections. Additional BC should only be performed when an endovascular or material infection is suspected, or in case of chills or septic shock. However, repeated BCs may account for one-third of all BCs handled in the microbiology laboratory [5]. In our hospital, approximately 70,000 BCs are performed each year and discussions with physicians have suggested that in many instances BCs were unnecessarily repeated the days following the initial prescription. The medical staff at our hospital comprises 900 senior physicians and 700 residents from various specialties. Due to the number and turnover of medical staff, it is nearly impossible to implement training campaigns on BC guidelines. These guidelines are communicated, but without any visible impact on practices, as observed in other settings [6]. In previous studies, medical education alone was not shown to produce sufficient changes in physicians' attitudes to prescribing tests or drugs [7,8]. Interventions that associate multiple components (such as teaching, financial incentives, audit, and feedback, etc.) are theoretically the most successful [9–11], but are costly and difficult to implement. Other types of interventions (such as implementing alerts, informing prescribing physicians of test costs, using request forms to limit test prescription) would not be appropriate in our situation [12–14].

Two previous studies have shown that an intervention associating a poster with an image of a pair of eyes looking at the reader with a message was found more effective than the same message without the image. The first study aimed to improve hand hygiene compliance and the second to improve contributions to an honesty box used to collect money for drinks in a university coffee room [15,16].

We hypothesized that this kind of intervention would allow us to reach out to our large population of physicians at a comparatively low cost, while being more effective than a mere poster stating BC guidelines.

We performed a randomized controlled trial to assess whether a poster, associating an image of eyes looking at the reader with a summary of BC sampling guidelines, reduced the rate of BC samples collected.

MATERIALS AND METHODS

Setting and design

We performed a single center cluster randomized trial, comparing the rate of BCs between the intervention group and the control group. This trial was conducted in 2015 in a 2,500-bed university hospital in France.

Inclusion and exclusion criteria

Adult acute care wards (1,614 beds) and subacute care and rehabilitation wards (SCR) (334 beds) were included, with the exception of the emergency department (ongoing BC improvement intervention), the infectious disease ward (familiar with BC guidelines). The ophthalmology ward, long-term care wards, and day care wards were not included due to the low number of BCs performed in these settings.

Randomization

The randomization unit was the ward. A cluster study was performed, by randomizing participating wards between the intervention and control groups. Randomization was stratified on the medical specialty (medicine, surgery, SCR, or intensive care).

Intervention

For ethical reasons, all wards received a minimum baseline intervention consisting in an email recalling the guidelines.

The intervention included the following components:

- an explanation of the trial and a recall of the guidelines during a regular ward meeting. The physicians present on the day of the meeting benefited from this information. No further meetings were proposed for non-attendees. The meeting lasted about 15 minutes;
- immediately after the meeting, the poster (Figure 1) was placed by the hygiene team in strategic areas of the ward (treatment room, medical office, visiting trolley, etc.) chosen in consultation with the clinical team. The meetings took place between September 7, 2015 and October 2, 2015 according to the ward.

The clinical teams of the intervention group were asked to avoid discussing the trial with other teams to avoid bias between intervention and control groups.

Period

In the intervention group, the post-intervention period was defined as the two months following the date of the meeting. The pre-intervention period corresponded to the same two calendar months during the year 2014, to minimize the likelihood of seasonal variation and to ensure that the residents had similar levels of experience.

In the control group, the pre-intervention period was September 1, 2014 to October 31, 2014 and the post-intervention period was September 1, 2015 to October 31, 2015.

Data collection

The number of BCs and hospital days per ward for the pre- and post-intervention periods were collected from hospital databases. All BCs performed by the wards participating in the trial were included. We recorded the number of positive BCs.

True positive blood cultures

A BC was defined as positive if at least one vial was positive with a microorganism other than coagulase-negative staphylococci, *Bacillus* spp., *Corynebacterium* spp., *Micrococcus* spp., *Propionibacterium* spp. For these microorganisms, a positive BC was defined as two vials tested positive within 48 hours.

Outcomes

The primary endpoint was the absolute difference between the incidence of BCs per 1,000 days of hospitalization in the post- and pre-intervention periods. The secondary endpoint was the proportion of positive BCs.

Statistical analysis

We conducted a “difference in difference” analysis, under the assumption that the differences between the groups would have remained constant if the intervention had been ineffective. The unit of analysis was the ward. For each ward, we calculated the absolute difference in incidence rates between the post- and pre-intervention periods. Results are presented with

the median and the interquartile interval. Given the asymmetric distribution of these differences and the small number of wards, we used a Mann-Whitney U test for “between groups” comparisons and a Wilcoxon test for matched series for “between periods” comparisons to compare pre/post intervention differences. A p value <0.05 was considered statistically significant. All analyses were performed with SAS (version 9.4, SAS Institute, Cary, NC).

Ethics

Given the study design, no informed patient consent was required according to French regulations. The trial was approved by our University Hospital’s Quality Committee.

RESULTS

Thirty-one wards (15 intervention wards and 16 control wards) participated in the study (Table 1). There were 78,593 and 78,314 patient-days, and 4,295 and 3,887 BCs in the pre- and post-intervention periods, respectively. A significant decrease in the rate of BCs was observed between the pre- (54.6/1,000 days) and post-intervention periods (49.6/1,000 days) ($p=0.014$). There was a significant decrease in the number of BC prescriptions in the control group ($p=0.025$), but not in the intervention group ($p=0.083$) (Figure 2).

The median difference in BC incidence rates between periods was -1.863 [-11.941; 1.007] in the intervention group and -5.824 [-14.763; -2.217] in the control group ($p=0.27$).

There were 439 and 336 positive BCs in the pre- and post-intervention period, i.e. a positivity rate of 102.2 and 86.4/1,000 BCs, respectively. The median difference in positivity rates between the periods was equal to -8.255 [-14.351; 4.011] in the intervention group and -16.210 [-76.362; 0.0] in the control group ($p=0.47$).

DISCUSSION

The intervention did not reduce the rate of BCs. Interestingly, we observed an overall significant decrease between the two periods, independent of groups, a significant decrease in the control group, and a non-statistically significant decrease in the intervention group.

Several factors may explain the lack of effect of the intervention. First, the policy of reducing inappropriate prescriptions at our hospital may have led physicians to reduce BC prescription, which could have masked the effect of our intervention. Second, computerized prescription was implemented in our hospital during the study period. As an end-of-prescription date must be entered in computerized prescriptions but not in manual prescriptions, computerization is likely to be associated with a reduction in the number of BCs. Computerized prescription was progressively implemented within our institution, and as a consequence we were unable to check prescriptions in the control group. This could have biased our results. Third, due to the serious consequences of bacteremia, behavior regarding BC prescription and collecting may be more difficult to modify by this intervention than the interventions by Bateson *et al.* and King *et al.* [15,16].

In our study the BC positivity rates decreased between the two periods in both groups. This could be an unexpected negative effect of the intervention: an increased need to reduce the number of BCs may have led to the suppression of some BCs that would ultimately have been relevant (i.e. positive).

This study presents several strengths: its controlled randomized design, the use of the double difference method, and the fact that it was conducted in almost all wards of the hospital.

The first limitation of the study is its single center design. Second, as data was collected using the hospital computerized information system, it was not possible to determine whether BC

sampling during the days following prescription was in accordance with guidelines; however, the impact of these factors would have been the same in both groups.

Conclusion

There was a lack of evidence that the intervention reduced the number of blood culture samples collected. This result may be due to the choice of BC as a target of good practice, but also to confounding factors such as the present stringent policy of decreasing unnecessary costly testing, which represent strong constraints for hospital wards.

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Figure 1. Poster associant une image d'un regard dirigé vers l'observateur et les recommandations sur les prélèvements des hémocultures, visant à diminuer le nombre d'hémocultures

Figure 1. Poster with an image of eyes looking at the reader with a written summary of blood culture sampling guidelines, aimed at reducing the number of blood cultures

Recommendations for blood culture collection



On the day of prescription:

TWO PAIRS OF BLOOD CULTURE BOTTLES SHOULD BE COLLECTED 30-60 MINUTES APART

- If an urgent antibiotic treatment is required, the two pairs of blood culture bottles should be collected simultaneously (first the vials for aerobes, and then the vials for anaerobes).

DO NOT COLLECT MORE THAN TWO PAIRS of blood culture bottles

The following days: NO OTHER COLLECTION

Unless (based on medical prescription):

- suspicion of material or endovascular infection
- chills
- septic shock
- antibiotic holiday (one pair of blood culture bottle a day should be collected in that case)
- expert opinion

(minimum volume of blood per vial = 10 mL)



30-60 min



Figure 2. Taux d'incidence des hémocultures pour 1 000 journées d'hospitalisation dans les groupes intervention et contrôle pendant les périodes pré- et post-intervention

Figure 2. Incidence rate of blood cultures per 1,000 days of hospitalization in the intervention and control groups in the pre- and post-intervention periods

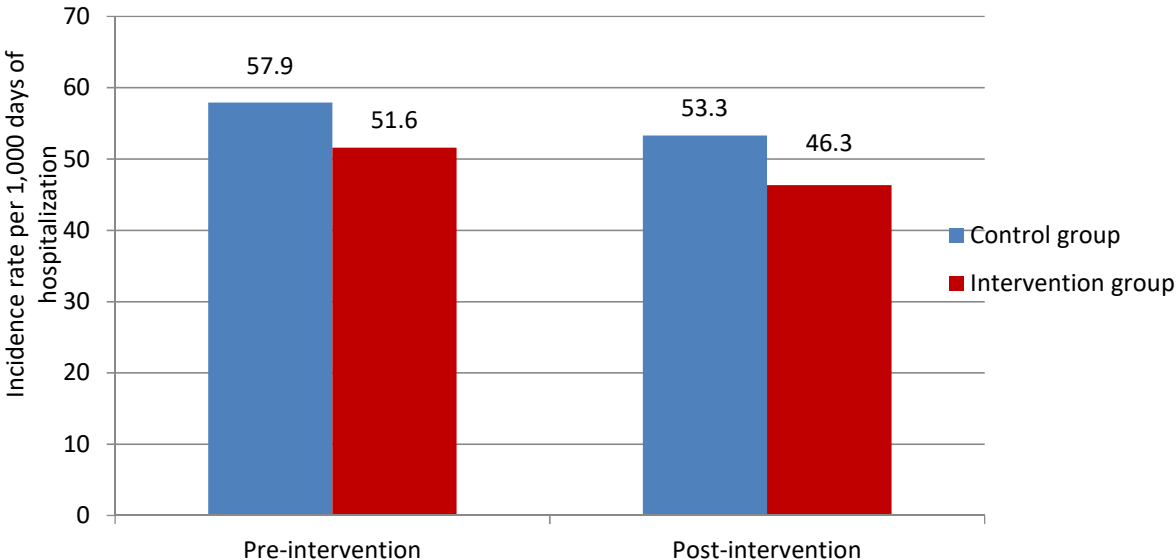


Tableau 1. Différence des taux d'incidence des hémocultures entre les périodes pré- et post-intervention pour chaque service des groupes intervention et contrôle

Table 1. Difference in blood culture incidence rates between pre- and post-intervention periods for each ward in the intervention and control group

Intervention group	Absolute difference in incidence rates of blood cultures per 1,000 days of hospitalization	Control group	Absolute difference in incidence rates of blood cultures per 1,000 days of hospitalization
Medicine		Medicine	
Internal medicine	-2.64	Geriatric medicine (Site 1)	-7.58
Endocrinology/Diabetology	2.19	Rheumatology	-19.70
Geriatric medicine (Site 2)	-14.43	Cardiology	-8.49
Palliative care	1.11	Nephrology	-4.06
Gastroenterology	4.70	Pneumology (Site 3)	-0.84
Pneumology (Site 1)	-2.30	Dermatology	-25.64
		Neurology	-3.02
Surgery		Surgery	
Vascular and thoracic surgery	-13.20	Stomatology	-19.40
Orthopedic surgery	-1.86	Obstetric gynecology	-2.68
ENT	0.21	Neurosurgery	-11.35
Cardiac surgery	-25.89	Urology	-13.22
		Digestive surgery	13.18
Intensive care		Intensive care	
Neurosurgery intensive care	-86.84	Surgical intensive care	-102.16
Cardiac surgery intensive care	0.90	Medical intensive care	73.29
Rehabilitation care		Rehabilitation care	
Geriatric rehabilitation care (Site 3)	-1.71	Rehabilitation care (Site 4)	-0.09

Pneumology rehabilitation care	-10.68	Rehabilitation care (Site 2)	-3,83
Neurology rehabilitation care	2.21		
