Journal of Hospital Infection 98 (2018) 232–235

Available online at www.sciencedirect.com

Journal of Hospital Infection

journal homepage: www.elsevier.com/locate/jhin

Short report

Optimization of the blood culture pathway: a template for improved sepsis management and diagnostic antimicrobial stewardship

M.J. Weinbren [a,*], M. Collins [a], R. Heathcote [b], M. Umar [c], M. Nisar [c], C. Ainger [b], P. Masters [b]

[a] Department of Microbiology, Chesterfield Royal Hospital Foundation Trust, Chesterfield, UK
[b] Department of Blood Sciences, Chesterfield Royal Hospital Foundation Trust, Chesterfield, UK
[c] Department of Medicine, Chesterfield Royal Hospital Foundation Trust, Chesterfield, UK

ARTICLE INFO

Article history:
Received 19 August 2017
Accepted 29 December 2017
Available online 5 January 2018

Keywords:
Blood cultures
Antibiotic stewardship
Sepsis
Gram-negative
Escherichia coli

SUMMARY

Laboratory processing of blood cultures has remained static over the past 30 years, despite increasing antibiotic resistance and advances in analyser design. At the study hospital, siting the blood culture analyser in the blood sciences laboratory and optimizing the pre-analytical and analytic phases of blood culture management resulted in a reduction in the time taken to detect most blood culture isolates to <12 h. Fifty percent of positive blood cultures containing *Escherichia coli* were definitively reported with antibiotic susceptibilities in <24 h. More than 85% of blood cultures positive for *E. coli* had antibiotic susceptibilities reported within 36 h of collection, compared with 66 h at a comparator hospital.

Introduction

Turnaround times of pathology results (from collection through to clinical interaction/issuing a report) have a significant impact on individual patient management, but also have a wider bearing on infection control/public health, hospital patient flows and antibiotic stewardship. Although blood cultures are collected from among the sickest patients, they are rarely treated as urgent. Without audit of the blood culture pathway (using specimen collection as the starting point), microbiologists and clinicians are unaware of significant preventable delays in obtaining results.

Over 30 years ago, Holliman *et al.* highlighted the need for rapid microbiology results, reporting that antibiotic treatment was either initiated or altered on the basis of laboratory results in half of patients with significant positive cultures [1]. This was in an era where resistance to third-generation cephalosporins, quinolones and aminoglycosides was uncommon. Since then, antibiotic resistance rates have increased in clinical isolates, culminating in the emergence of carbapenamase-resistant Enterobacteriaceae. Blood culture technology has

* Corresponding author. Address: Department of Microbiology, Chesterfield Royal Hospital Foundation Trust, Calow, Chesterfield S44 5BL, UK.
E-mail address: michael.weinbren@nhs.net (M.J. Weinbren).

https://doi.org/10.1016/j.jhin.2017.12.023
0195-6701/

improved over the past decades, with laboratories now using analysers that monitor samples every 10–15 min and detect positive cultures 24 h/day. However, these developments have not been matched by changes in laboratory practice.

The present-day convergence of the need for improved recognition and management of sepsis, increasing antibiotic resistance, and the need for enhanced antibiotic stewardship places greater demands on the laboratory for improved turnaround times of blood cultures, with both positive and negative cultures having an impact on patient management.

The authors devised an optimized blood culture pathway in the study hospital. This study investigated the impact of this pathway on the turnaround times of results, and compared the blood culture turnaround times at the study hospital with those of five other laboratories that had not optimized their pathways, and one laboratory that had taken some steps to improve blood culture handling and processing.

Methods

Optimization of the blood culture pathway

Addressing load delays

The guidelines of the UK Standards for Microbiology Investigations indicate that 100% of blood cultures should be loaded within 4 h of collection [2]. A baseline audit prior to the intervention revealed that more than 60% of blood cultures were taking >4 h to be loaded at the study hospital. This was corrected in three stages:

- Moving the FX blood culture analyser (Becton Dickinson, Oxford, UK) from microbiology into the blood sciences laboratory, allowed blood cultures to be loaded 24 h/day.
- Replacing glass bottles with plastic blood culture bottles, allowing samples to be sent via the hospital air tube system.
- Education of clinical staff on the importance of collecting and sending blood cultures to the laboratory without delay.

Addressing unload delays

Blood sciences staff processed blood cultures, flagging positive cultures outside of routine microbiology hours (08:30–20:00 h). Samples were plated on to routine laboratory media, including plates for direct Gram-negative sensitivity testing, extended-spectrum beta-lactamase testing and gentamicin minimum inhibitory concentration determination, in a portable class I safety cabinet. A Gram stain was not performed.

Audit of blood culture processing in other centres

Audit of other hospitals

Laboratories serving five other hospitals (teaching and non-teaching, some off-site) in the same health region as the study hospital provided the following data points on 27 consecutive *Escherichia coli*-positive blood cultures:

- time when blood culture collected;
- time when loaded on the analyser;
- time when flagged positive; and
- time when removed from the analyser.

None of these laboratories had optimized their blood culture pathways. In addition, the same data set was collected for 50 consecutive blood cultures positive for *E. coli* at one other hospital (with an on-site laboratory) in another health region; a further data point (time when sensitivity data were inputted into the laboratory information management system) was also measured. These data were compared with the same time points in the study hospital.

Appropriateness of empirical antibiotic therapy

Using a *pro forma*, the initial antibiotic therapy of 106 consecutive patients with significant positive blood cultures was reviewed. Antibiotic therapy was considered to be appropriate if the patient was prescribed at least one agent that was active against the blood culture isolate based on in-vitro antibiotic susceptibility testing. For deep-seated infections due to *Staphylococcus aureus*, agents with modest activity (e.g. co-amoxiclav) were considered as partial therapy. Inappropriate therapy was defined as no antibiotic treatment, any oral antibiotic therapy in a patient who was septic, or parenteral treatment with antibiotics to which the pathogen was resistant. The authors also considered whether Gram stain results, or identity of the organism, before antibiotic susceptibilities were available could have corrected inappropriate empirical therapy.

Results

Blood cultures positive for E. coli

Ninety-five percent of blood cultures were loaded within 2 h at the study hospital. In contrast, in the non-optimized hospitals, blood culture samples sometimes took over 24 h to load after collection 95% of bottles, with a range of 16–26 h (Figure 1). Ninety-seven percent of cultures positive for *E. coli* at the study hospital were removed from the analyser within 18 h of collection, compared with 42–56 h in the other hospitals (Figure 1). The average time from collection to unloading at the study hospital was 12.79 h, compared with 18.87–30.28 h in the other hospitals.

The study hospital was also substantially quicker than the comparator hospital that had optimized its blood culture pathway at three defined time points. The overall impact of this was that >85% of blood cultures positive for *E. coli* had antibiotic susceptibilities reported within 36 h of specimen collection at the study hospital, compared with 66 h at the comparator hospital (Figure 2).

Appropriateness of empirical antibiotic therapy

Of 106 consecutive significant positive blood cultures, almost one-third (N=34) of patients did not receive appropriate empiric antibiotic therapy. Analysis of failure of initial empirical therapy showed that a Gram stain result could have corrected treatment in 19 (55.9%) cases, and enabled early identification of the organism in a further five (14.7%) cases. Early availability of antibiotic susceptibilities would have influenced treatment in 10 (29.4%) cases.