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Clinical and economic evaluation of the impact of rapid microbiological diagnostic testing

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Summary The clinical value of information provided by the Microbiology Laboratory may be reduced by the time it takes to generate results for healthcare providers. The aim of this study was to measure the clinical and economic impact associated with rapid reporting of microbiological results.
Methods: 574 hospitalized patients with a bacterial clinical infection confirmed by culture were evaluated. 284 hospitalized patients were included in the historical control group (results available the day following the analysis) and 290 in the intervention group (results available the same day of the analysis). The Vitek® 2 system (bioMérieux) was used for identification and antimicrobial susceptibility testing in both groups.
Results: Faster reporting of microbiological results enabled the clinician to optimize the antibiotic treatment sooner ($P < 0.001$). This reduction in turnaround time (17.6 h) was associated with improved clinical outcome, a significant reduction in the length of hospitalization and the number of microbiological and biochemical tests performed. Intubation requirements were significantly lower in the intervention group. Mortality rates did not differ significantly between the two groups. Costs incurred for patients in the intervention group were significantly lower than those in the control group, including costs for Microbiology Laboratory testing, antibiotic costs, length of hospitalization and other patient care costs.
Conclusions: Rapid microbiological information was associated with quality improvement seen in earlier changes in antibiotic use, an improved clinical outcome and financial benefits.

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Introduction

Microbiology laboratories play an important role in the appropriate use of antibiotics in hospitals. However, the clinical usefulness of the information they provide is sometimes reduced by the length of time it takes to generate that information and report results to healthcare providers. Unfortunately, this can result in up to 50% of the antibiotic prescriptions in hospitals being considered inappropriate.[1]

Besides the unnecessary economic cost that the inappropriate prescribing of antibiotics generates and the harm that can cause to the patient, it has an important epidemiological repercussion, since it leads to the selection of resistant bacteria strains and superinfection by multiresistant microorganisms or of more difficult treatment. At present, the interest in the development of antimicrobial stewardship programs designed to improve rational use of antibiotics in hospitals is increasing.[1–3] However, only a few studies have addressed the impact of rapid techniques on patient outcomes.[4–8] The aim of this study was to measure the clinical and economic impact of rapid microbiological information.

Patients and methods

Setting

The study was conducted from December 2003 to December 2007 in the Clínica Universidad de Navarra (Pamplona, Spain), a 400-bed university medical centre. A historical control group of patients hospitalized between December 2003 and December 2005 was followed retrospectively, and an intervention group of hospitalized patients admitted between December 2005 and December 2007 was followed prospectively. The Vitek® 2 system (bioMérieux, Marcy l'Etoile, France) was used for identification and antimicrobial susceptibility testing in both groups.

Study population

The study was restricted to: a) patients with clinical infection diagnosis and treated by the Infectious Diseases Division, and b) patients with bacterial infections from whom a clinically significant isolate characterized with the Vitek® 2 system, was recovered. The "index positive culture" was defined as the first culture from which one or more microorganisms were recovered and "case" as every microorganism with clinical implication isolated, identified and obtained with its susceptibility profile. All the study patients were evaluated by an infectious diseases specialist. It was determined that 528 patients would be needed to demonstrate a 22% reduction in economic costs, as was detected in the study by Doern et al.[6] (power of 80% and two-tailed of 0.05) [Siz (v.1), Cytel Software, Cambridge, USA].

Reporting of results

The results of identification and susceptibility tests (preliminary or final) in the intervention group were always reported directly by the Clinical Microbiologist to the infectious diseases physician by telephone (until 10 p.m.) as soon as they became available the same day of the analysis by the Vitek® 2, and provided by using a computerized Laboratory Information System when they were finalized. Specimens of patients attended by the Infectious Diseases Division were processed earlier in the morning than patients from other clinical services. In the control group the results were not available on the same day that the isolate was placed in the Vitek® 2 instrument (as the traditional workflow was in place), so reporting of results was delayed until the following day and just the computerized Laboratory Information System was used.

Variables recorded included

Variables evaluated were age, sex, unit of admission, severity of the underlying illness as defined by the McCabe-Jackson criteria,[9] Charlson comorbidity score,[10] type of infectious disease, microbiological isolates, origin of the index positive infection (community acquired or nosocomial), specimen source for their index positive culture, number and route of administration of antibiotics/antifungals/antivirals before and after microbiological results report, antibiotic use adjusted or not adjusted according to the susceptibility profile after it becomes available, duration of hospital stay in the Conventional (non-intensive care) Hospitalization Unit and Intensive Care Unit, number and type of procedures performed in the Departments of Clinical Microbiology, Clinical Biochemistry, Hematology, Radiology, Anatomical Pathology, Nuclear Medicine, Cardiology, Pulmonology, Pharmacy, Pharmacology, days receiving mechanical ventilation and mortality rates. Mortality rates were examined both as total mortality (all causes) at two points in time: during hospitalization and up through 3 months following discharge and, specific mortality attributable to pathogen identified in the index positive culture. Other outcome parameters recorded were changes in antibiotic therapy (substitution, elimination, addition or initiation) and time intervals between the introduction of the specimen in the Vitek® 2 system, the return of the results to the physician, and the time of the changes in antibiotic therapy. Time points of specimen collection, specimen arrival and processing, and times of oral and automated reporting of identification and antimicrobial susceptibility testing results were recorded as well. For the economic study, direct fixed costs, direct variable costs and indirect costs were considered during hospitalization. These data were updated to 2007 using the Consumer Price Index.[11]

The study was approved by the Medical Ethics Committee of the Clínica Universidad de Navarra and no informed consent was required.

Statistical analysis

All analyses were performed using SPSS software, version 15.0, at a significance level of 5%. We used chi-square test, Fisher's exact test, Student's Paired *t* tests and Mann–Whitney *U* test to compare the patient groups. Interrupted time series analysis was performed to evaluate the impact of the intervention on length of hospital stay and total costs. Because of the skew observed in the underlying data, the model used the logarithm of these two dependent variables.