Validity of susceptibility testing of uropathogenic bacteria in general practice

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SUMMARY

Resistance of uropathogenic bacteria to antibiotics is an increasing problem in primary health care. The aim of this study was to evaluate antibacterial susceptibility testing of uropathogenic bacteria when performed in general practice. Urine specimens with a known quantity of typically uropathogenic bacteria were sent to 25 general practices. The predictive values of testing a bacterial strain as susceptible ranged from 0.89 (nitrofurantoin) to 1.00 (sulphamethizole), and the predictive value of testing a bacterial strain as resistant ranged from 0.55 (trimethoprim) to 0.90 (nitrofurantoin). Interventions to improve the validity of susceptibility testing are desirable if the test should be incorporated in the diagnostic armamentarium in general practice.

Keywords: antibiotics; uropathogenic bacteria; urine.

Introduction

URINARY tract infections (UTI) account for about 2–5% of contacts in general practice.[1] Resistance to antibiotics is an increasing problem and, today, one-quarter to one-third of uropathogenic bacteria are resistant to sulphamethizole and ampicillin, which are among the most frequently used drugs for UTI.[2,3] Devices for susceptibility testing are available for use in general practice, but few studies have examined the validity of these tests when performed in practice. The aim of this study was to compare results from antibacterial susceptibility testing in general practice with those obtained at a bacteriological laboratory.

Method

The study was carried out in 1995 and included 25 practices in the County of Funen, Denmark (174 general practices, 300 physicians). Identical samples of urine specimens, containing pure cultures of resistant or susceptible bacteria (*Escherichia coli, Proteus mirabilis, Enterobacter cloacae*, and *Enterococcus faecalis*), were transported — refrigerated — to all practices and examined on the same day. The prevalence of resistant bacteria in the specimens corresponded approximately with the occurrence of resistant bacteria among patients with UTI in general practice.

Practices used their standard routine of susceptibility testing: Sensicult® dip-slide, Orion Diagnostica (15 practices) or Iso-Res® agar-plate, Becton-Dickinson (10 practices). No instruction in susceptibility testing was given prior to the study. As gold standard we used a standardized disc diffusion technique performed at the local bacteriological laboratory.[4]

Results

Table 1 shows the percentage of correct results for each antibiotic tested and the corresponding predictive values of susceptibility testing in general practice. The predictive values of testing a bacterial strain as susceptible ranged from 0.89 (nitrofurantoin) to 1.00 (sulphamethizole). The predictive value of testing a bacterial strain as resistant was, however, considerably lower, ranging from 0.55 (trimethoprim) to 0.90 (nitrofurantoin).

The percentage of correct tests varied between practices from 47% to 100% with a median of 87%. Practices using the agar plate system showed a significantly higher percentage of correct results (median = 90%, range = 80–100%) than practices using the dip-slide system (median = 82%, range = 47–94%; Mann–Whitney, $P<0.05$).

Discussion

This study showed substantial discrepancies in the results of antibiotic susceptibility testing between general practice and the bacteriological laboratory. Most discrepancies resulted from classification of susceptible bacteria as resistant to the antibiotic drug examined. Thus, only about half of the strains tested as resistant to trimethoprim were in fact resistant, and only two-thirds tested as resistant to sulphamethizole were in fact resistant. On the other hand, more than 90% of tests indicating susceptibility predicted a correct result concerning the agent in question.

The standard method for susceptibility testing in bacteriological laboratories is the disc diffusion method. Comparative studies only lead to small discrepancies when comparing results from different bacteriological laboratories.[5] Other studies evaluating susceptibility testing in general practice support our findings. Kjærulff thus found that a considerable number of susceptible bacteria were classified as resistant. He also found a higher validity of the agar plate method than the dip-slide method.[6] Dornbusch *et al* compared susceptibility testing by a dip-slide method in general practice with a standardized susceptibility testing performed in a bacteriological laboratory.[7] Disagreement was found in 11% (nitrofurantoin) to 36% (ampicillin) of the results and, in the majority of practices, disparities resulted from classification of susceptible bacteria as resistant. Ferry *et al* also found higher predictive values for antibiotic sensitivity (93%) than for antibiotic resistancy (50%).[8]

Several types of failure may occur when performing a susceptibility testing. Inexperienced individuals may interpret a faint background growth within the inhibition zone as resistant. Non-active discs or substances in the agar that are antagonistic to the antibiotic discs may reduce the inhibition zone.[7] If the inoculum is too big, the density of the colonies on the plate will increase, which in turn will lead to a decrease of the inhibition zones. Preferably, the colonies should be regularly spread on the plate and grow semi-confluently — 'shoulder by shoulder' — on the agar. With the dip-slide technique the inoculum cannot be standardized as the ordinary disc diffusion test.[9] This may explain

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Table 1. Results of susceptibility testing of urine specimens (pure cultures of Escherichia coli, Proteus mirabilis, Enterobacter cloacae, and Enterococcus faecalis) performed in general practice. The percentage of correct results (CI = 95%) and the predictive values of test results are shown for each antibiotic analysed. Calculation of predictive values is based on a prevalence of resistant bacteria according to the occurrence among patients with urinary tract infections in general practice.

	Percentage of correct results		Predictive values	
	Susceptible bacteria	Resistant bacteria	Test indicating susceptibility	Test indicating resistance
Ampicillin	73.0 (64.7–80.2)	91.5 (83.9–96.2)	0.93 (0.86–0.97)	0.70 (0.61–0.78)
Sulphamethizole	60.6 (51.9–68.8)	100 (96.1–100)	1.0 (0.92–1.0)	0.63 (0.55–0.71)
Nitrofurantoin	95.0 (89.3–98.1)	80.0 (67.7–88.6)	0.89 (0.82–0.94)	0.90 (0.80–0.96)
Ofloxacin	95.7 (90.2–98.6)	–	–	–
Trimethoprim	80.6 (69.5–88.9)	94.4 (72.7–99.8)	0.98 (0.91–0.94)	0.55 (0.36–0.73)
Mecillinam	76.5 (62.5–87.2)	97.2 (85.5–99.9)	0.98 (0.87–1.0)	0.74 (0.60–0.86)

some of the discrepancy in the validity between the two methods.

In this study we examined susceptibility testing on pure cultures. If a mixture of bacteria is present, however, the results obtained from a direct susceptibility testing are unreliable. Antibiotic susceptibility testing should be limited to pure cultures. Hoffmann *et al* found that only 2% of results were correct if a mixture of bacteria was tested in general practices.[10] The estimates of validity found in this study were all based on monocultures and may therefore be too optimistic.

Estimates of predictive values of susceptibility testing depend on the prevalence of resistant bacteria among the patients examined. Our strains were selected from patients with UTI. About 40% of strains were resistant to sulphamethizole and the predictive value of finding a sulpha-resistant bacteria was 0.63. In a population with a lower prevalence of sulpha-resistant bacteria the predictive value of a test indicating resistant bacteria may be lower owing to a higher frequency of false-positive results, and vice versa for a population with a higher prevalence of resistant bacteria.

Susceptibility testing for use in general practice should be valid, reliable, easy, rapid, and economic. If these criteria are not met, forwarding the specimen to a bacteriological laboratory for susceptibility testing should be considered instead. A wrong interpretation of a susceptible bacteria as a resistant restricts the choice of antibiotics and may lead to the prescribing of more broad-spectrum and potent antibiotics, which in turn may lead to more resistant bacteria.[3] On the other hand, wrong interpretation of resistant bacteria may lead to an insufficient treatment. The low validity of susceptibility testing in general practice is discouraging, and training courses to improve the quality of susceptibility testing should be considered.

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