

Cost-effectiveness of culture-guided antimicrobial prophylaxis for the prevention of infections after prostate biopsy



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ARTICLE INFO

Article history:

Received 29 October 2015

Received in revised form 4 December 2015

Accepted 8 December 2015

Corresponding Editor: Eskild Petersen, Aarhus, Denmark.

Keywords:

Antimicrobial prophylaxis

Rectal culture

Prostate biopsy

Post-biopsy infection

Cost-effectiveness analysis

SUMMARY

Background: Clinical findings suggest that the use of rectal culture-guided antibiotic prophylaxis reduces the infection rate following transrectal ultrasound-guided prostate biopsy (TRUSBx).

Methods: A decision-analytic model was designed to compare the outcomes of TRUSBx performed with (rectal culture-guided group) and without (standard ciprofloxacin prophylaxis) rectal swab culture-guided antimicrobial prophylaxis in Hong Kong. The post-biopsy infection rate, infection-related costs, quality-adjusted life years (QALYs) lost for infection, and incremental cost per QALY saved (ICER) were assessed. Model inputs were retrieved from local epidemiology data and the medical literature. A sensitivity analysis was performed to test the robustness of the model results.

Results: Base-case analysis showed that the infection rate in the culture-guided group was reduced from 2.42% to 0.23% and saved 0.0002 QALYs, with a lower cost (USD 31.4 versus USD 55.6) (USD 1 = HKD 7.8). The number needed to screen to prevent an infection episode was 45.7. The hospital days avoided per 100 patients using culture-guided prophylaxis was 7.08 days. The relative effectiveness of culture-guided antimicrobial prophylaxis versus standard prophylaxis in carriers and non-carriers of FQ-resistant rectal flora were identified as potential influencing factors. In 10 000 Monte Carlo simulations, ICERs of the culture-guided group were below the willingness-to-pay threshold 99.12% of the time.

Conclusions: Using rectal culture-guided antimicrobial prophylaxis for men undergoing TRUSBx appears to be a cost-saving strategy to avert post-biopsy infection and QALY loss in Hong Kong.

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1. Introduction

Despite the lower incidence of prostate cancer in Asian regions than in Western nations, the Hong Kong Cancer Registry has reported prostate cancer to be the third most common cancer in men.^{1,2} Transrectal ultrasound-guided prostate biopsy (TRUSBx) is a commonly performed procedure for the diagnosis of prostate cancer, and infection (including urinary tract infection, prostatitis, and sepsis) is a well-established complication of this procedure. The rate of infection post-TRUSBx ranges from 0.5% to 6.6%, with hospitalization rates between 0.5% and 4.8%.³

Fluoroquinolones (FQs) are frequently used for periprocedure antimicrobial prophylaxis,⁴ yet the emerging prevalence of FQ-resistant bacteria in faecal carriage of patients undergoing TRUSBx has increased the risk of post-biopsy infection.⁵ Pre-biopsy rectal

swab culture is therefore suggested to identify the resistance of the rectal flora prior to selecting antimicrobial prophylaxis. The findings of clinical trials strongly suggest that antimicrobial prophylaxis be directed by rectal culture to reduce the odds of infection, with the possibility of eliminating post-biopsy infection.^{6,7}

With the initiatives of the Department of Health to enhance public awareness of prostate cancer screening, the number of males undergoing TRUSBx is anticipated to increase in Hong Kong.⁸ A recent study reported a high prevalence of FQ-resistant rectal flora (40.4%) in Hong Kong males undergoing TRUSBx, suggesting that a targeted approach to antimicrobial prophylaxis using rectal culture is warranted.⁹ A cost-effectiveness analysis is essential to facilitate the decision-making process with regard to implementing pre-TRUSBx rectal culture swab to guide the selection of prophylactic agent. The objective of this study was to examine the potential costs, post-biopsy infection rate, and health-related quality of life of men undergoing TRUSBx with or without periprocedure rectal swab culture, from the societal perspective of Hong Kong.

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2. Methods

2.1. Model design

A decision-analytic model (Figure 1) was designed to compare the economic and clinical outcomes of TRUSBx performed with (rectal culture-guided group) and without (standard group) rectal swab culture-guided antimicrobial prophylaxis. The outcomes simulated in the present model included the post-biopsy infection rate, infection-related direct medical cost and indirect cost, and quality-adjusted life years (QALYs) lost for post-biopsy infection. A hypothetical cohort of male subjects aged 55 years and above (newly diagnosed cases of prostate cancer in Hong Kong have mainly fallen into this age group¹⁰) undergoing TRUSBx were included in this model. Exclusion criteria included allergy to FQ.

Rectal swabs would be collected for subjects in the culture-guided group within 1 month prior to TRUSBx.^{6,7} The choice of culture-specific regimen included sulfamethoxazole–trimethoprim, cefuroxime, or cefazolin monotherapy and the combination of ciprofloxacin and gentamicin.^{6,7,11,12} Subjects in the standard group would receive oral ciprofloxacin before TRUSBx.^{5,6,13–15} A post-biopsy infection might occur in any patient in both study arms; those who were infected might be managed in the outpatient setting or be hospitalized. Post-biopsy infections were defined clinically, including urinary tract infection and blood-stream infection.^{6,7} No mortality as a result of post-TRUSBx infectious complications was reported in the local epidemiology study,⁹ and the present model therefore assumed no post-biopsy infection-related deaths.

2.2. Clinical inputs

A literature search of MEDLINE for the period 2000 to 2015 was performed using the following key terms: “prostate biopsy”, “fluoroquinolone resistance”, “rectal flora”, “antimicrobial prophylaxis”, “urinary tract infection”, and “bacteremia”. The selection criteria for the clinical trials were: (1) report written in the English language; (2) prevalence of FQ-resistant rectal flora was reported, and/or (3) the post-biopsy infection rate was reported. All articles retrieved by this process were screened for relevance to the model. For a variable that was reported in multiple studies, the weighted average was used to estimate the base-case value.

The clinical inputs are shown in Table 1. The base-case values of the following clinical inputs were estimated from an epidemiological study performed in Hong Kong Chinese men undergoing TRUSBx:⁹ prevalence of FQ-resistant rectal flora and post-biopsy infection rates in carriers and non-carriers of FQ-resistant rectal flora in the standard group. The prevalence of FQ-resistant rectal flora (40.4%) reported in Hong Kong was found to be much higher than those reported in other regions (10.8–19.6%).^{11,16–18} The variation in prevalence of FQ resistance was therefore examined

over a range of 10.8–40.4%. The base-case values of relative effectiveness of culture-targeted (versus standard) prophylaxis in carriers (100%) and non-carriers (79%) of FQ-resistant rectal flora were estimated from a clinical trial comparing the post-biopsy infection rate before and after the implementation of pre-procedure rectal culture.⁷ A broad range (34–100%), with the lower limit value (34%) reported in a case-control study,⁶ was examined in the sensitivity analysis for these two variables. The post-biopsy infection rate with culture-guided prophylaxis was calculated using the following equation: infection rate with standard ciprofloxacin prophylaxis \times (1 – relative effectiveness of culture-guided prophylaxis).

The hospitalization rate of post-biopsy infection and length of hospital stay were retrieved from outcome studies on post-biopsy infectious complications of TRUSBx.^{13–15,19} For infected patients who were managed exclusively in the outpatient setting, the number of outpatient visits was assumed to be 2 (range 1–3), including the first visit for symptom onset and diagnosis and the second visit for follow-up.

2.3. Cost inputs

The cost analysis of the present study was performed from the societal perspective of Hong Kong and included the direct medical cost (costs of rectal swab culture, standard and culture-guided prophylactic regimens, and inpatient and outpatient care for post-biopsy infection) and the indirect cost (loss of productivity during post-biopsy infection).

The standard prophylactic regimen for TRUSBx in Hong Kong was single-dose ciprofloxacin 500 mg taken perioperatively,⁹ and the empirical ciprofloxacin regimen varied from a single dose to 6 doses (3 days).^{5–7,13–15} Culture-guided regimens included monotherapy of sulfamethoxazole–trimethoprim, cefuroxime, or cefazolin,^{7,17} and the combination of ciprofloxacin and gentamicin.^{6,12} The costs of antibiotic prophylaxis were calculated from the unit cost of antibiotic(s) and the quantity taken.

The cost of infection for patients who were managed exclusively in the outpatient setting was estimated from the number of outpatient visits and cost per outpatient visit. The cost of infection for patients who were hospitalized included both inpatient and outpatient care. The cost of inpatient care was calculated from the length of stay and daily cost of hospitalization on the general medical ward. The model inputs for cost per outpatient visit and daily cost of the general medical ward were estimated from charges to non-residents of the Hospital Authority.²⁰ The Hospital Authority is the largest public healthcare provider for Hong Kong residents. It is non-profit making and is subsidized by the government, and the charges to non-residents were therefore assumed to represent solely the cost of the healthcare services without profit.

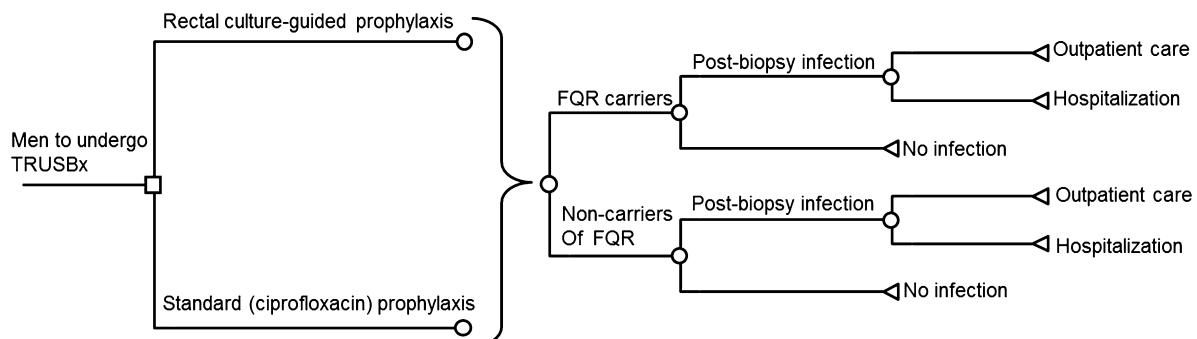


Figure 1. Simplified decision-analytic model (TRUSBx, transrectal ultrasound-guided prostate biopsy; FQR, fluoroquinolone resistance).

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