TUTORIALS IN POSTGRADUATE MEDICINE

UROLOGY

Edited by

G. D. CHISHOLM, ChM FRCS FRCSE

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WILLIAM HEINEMANN MEDICAL BOOKS LTD
LONDON

First published 1980

ISBN 0 433 05495 6

Film set in 11 point Times
Printed and bound in Great Britain
by W & J Mackay Limited, Chatham

Preface

It is not always easy for the postgraduate to find the right amount of information on a topic, especially when his own level of knowledge can be so variable. There may be too much detail or too little, or the information may be too diffuse or uncritical. In the traditional tutorial, teacher and student can soon establish their respective levels of knowledge and then develop the subject on the basis of the student's needs; for the written word to act as a tutorial it must satisfy all levels of knowledge, mixing a sound basis of fact with a critical evaluation of the subject. The teacher must hold the attention of the student and impart at least a framework of knowledge for future development; in some, he may excite sufficient interest for the student to take up the challenge of the many unresolved problems. Thus I am indebted to the contributors who have taken on this task of teacher with such skill and competence.

In Sections I, II and III of this book, the topics are the basic urological triad of infection, stone and malignancy; Section IV deals with the diagnostic approach to some important urological problems and finally, in Section V, contributors are asked to give their approach to a range of operative procedures. This book makes no attempt to be a comprehensive text of urology, but the design and selection of topics have allowed for these to be dealt with comprehensively; selected references should guide those in need of more detail.

While the title of the series emphasises the postgraduate, in the context of continuing medical education this now includes anyone after graduation—from pre-fellowship candidate to established consultant. Thus I am indebted to many colleagues and especially those in the Department of Urology at the Western General Hospital, Edinburgh, for their comments, reactions and advice on fulfilling the aims of a tutorial book directed at clinicians such as themselves.

I wish to thank the many people who have assisted me but in particular I wish to thank Mrs Edna MacDonald, who so skilfully prepared the manuscripts. I have also greatly appreciated the help of Mr Richard Emery and Mrs Ann Kirk of Heinemann Medical Books at the inception and during the production of this book.

Edinburgh, G.D.C.
September, 1979

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Infection

Chapter One Factors affecting urinary tract infection

F. W. O'Grady

It is now generally conceded that urinary tract infection is caused by organisms derived from the patient's own bowel and that infection develops by a series of steps which the organism must successfully negotiate. The first of these steps is colonisation of the anterior urethra, the second is transfer to the bladder, the third is growth within the bladder and the fourth—if the process is to extend to renal involvement—is the transfer of organisms to the kidney. It appears highly likely that the organism's success or failure at each of these steps is determined partly by properties of the organism and partly by properties of the host.

INTROITAL COLONISATION

Evidence that the organisms responsible for urinary infection are derived from the patient's own bowel depends largely on the similarity in the prevalence of different *Escherichia* serotypes in infected urines and faeces. Similar correspondence can be demonstrated between organisms recovered from the urine and those recovered from the introitus between episodes of infection (O'Grady, Richards, McSherry, O'Farrell and Cattell, 1970). It is, of course, possible that these introital organisms are not the initiators of infection but the result of contamination, and hence colonisation, of the introitus during infection. This possibility has been convincingly excluded by Stamey (1972) who has amassed overwhelming evidence from regular culture of the introitus that urinary infection develops sequentially through colonisation of the introitus by faecal organisms which are then transferred to the urine. Entirely analogous findings have been reported in young girls by Bollgren and Winberg (1976). Using repeated introital and urinary culture, Stamey (1972) has also shown that women who are subject to urinary tract infection are much more commonly introital carriers of enterobacteria than those who are not.

Apart from its importance in the genesis of urinary tract infection there is a particular reason for being interested in the relative prevalence of introital colonisation in uninfected as compared to frequently infected women. If introital colonisation by enterobacteria is the rule in frequently infected women and rare in others, culture of the introitus should provide a simple means of identifying those women who are at special risk. Our experience based on random swabs taken from the introitus of uninfected or frequently infected women between episodes of infection was that the difference, though present, was much less marked than that which Stamey had found and some other observers have had much the same experience.

Carrier status and infection

One possible explanation for this discrepancy is that only women who are persistent carriers of introital enterobacteria, and not those who are intermittent or occasional carriers, are at risk from urinary infection. An examination of this possibility, based on swabs taken at each clinic attendance, showed that there was indeed a distinct difference between persistent, intermittent and non-carriers in the frequency with which they suffered infection over a prolonged period of follow-up, but that the difference was far from absolute (Table 1). 'Persistent carriers' are defined as patients in whom introital enterobacteria were always recovered; 'intermittent carriers' are those from whom they were sometimes recovered and 'non-carriers' are those from whom they were never recovered.

TABLE 1

Frequency of urinary infection in relation to introital carriage of enterobacteria

Carrier	*Number of patients with urinary infections per annum*	
	None	*More than one*
Persistent	3	11
Intermittent	19	19
Never	15	4

Data from O'Grady *et al.* (1970).

Although frequent infection was much more common in women who were persistent carriers it certainly occurred in those who were non-carriers and, conversely, there were persistent carriers who did not suffer recognised infection even over a follow-up period of some years.

It may reasonably be objected to this study that swabs obtained

at clinic attendances are too irregularly spaced and ill-controlled in relation to episodes of infection and their treatment to demonstrate a clear distinction between the groups. We therefore defined groups of 'never infected' and 'frequently infected' patients as clearly as we could, and cultured the introitus regularly for six weeks, ensuring that the periods of examination were at least six weeks remote from preceding or succeeding urinary infections. The difference in the prevalence of introital carriage between the groups proved to be trivial (Cattell, Brooks, McSherry, Northeast and O'Grady, 1975).

There are a number of possible explanations for the difference between these and Stamey's findings which he has several times cogently argued. Whatever the cause of the difference, it is plain that in our hands the results of regular introital culture cannot be used to define women at risk from repeated urinary tract infection. We conclude that introital colonisation is a necessary but not inevitable prelude to urinary infection. In addition to any differences that may exist between women in their capacity to resist the further advance of enterobacteria colonising the anterior urethra, there may be differences amongst the enterobacteria themselves in their capacity to invade the urinary tract.

UROPATHOGENICITY OF ENTEROBACTERIA

The fact that the great majority of urinary infections are caused by relatively few of the large number of *Escherichia* serotypes has been used to argue that while the prevalence of a particular type in the faeces determines the likelihood that it will be presented to the introitus, special properties of the organism will determine whether it will establish itself in the anterior urethra and subsequently in the urine.

Many factors have been described as being important determinants of the capacity of *Escherichia* to give rise to urinary infection. It has been known for many years that *Escherichia* recovered from the urine are very much more frequently haemolytic than those recovered from the faeces (Cooke and Ewins, 1975). K-antigen content, the capacity to resist the bactericidal action of serum or of low vaginal pH and numerous other factors have been held to be features peculiar to those strains capable of infecting the urinary tract. We have examined a large number of such factors and have found the differences between strains recovered from infected urine or from the introitus and faeces of uninfected patients to be suggestive but far from absolute. In the case of haemolysis, a striking systematic recruitment of activity is seen on comparing strains derived from faeces, introitus, lower and upper tract infection

TABLE 2

Prevalence of haemolytic strains amongst *Escherichia coli* recovered from different sites

	Escherichia coli strains	
Origin	*Number tested*	*per cent haemolytic*
Introitus		
normal subjects	45	9
abacteriuric patients	75	21
Urine		
infection confined to lower tract	29	27
infection of upper tract	19	58

Data from Brooks (1976).

(Table 2), but even with this feature, which shows easily the most convincing correlation amongst the properties so far examined, 40% or more of strains responsible for proven upper tract infection were not haemolytic.

Constellation of properties

Nevertheless, the prevalence of many of the properties was significantly different in carried or infecting strains and it is possible that there is a constellation of properties which must be present together in *Escherichia* in order to render them capable of infecting the urinary tract. Brooks (1976) took the five properties amongst the many she had examined which appeared to give the best differentiation between carried and infecting strains, scored the presence or absence of the property as 1 or 0 and summed the scores for each strain. When she compared the scores of strains derived from different sites (Table 3) she found a clear distinction

TABLE 3

Combined scores of selected 'uropathogenicity properties' in *Escherichia coli* recovered from different sites

Site of origin	*Number of strains examined*	*Percentage of* Escherichia coli *strains from stated sites with scores for 'combined uropathogenicity properties' of* 0	1	2	3	4	5
Introitus							
normal subjects	45	11	36	31	11	9	2
abacteriuric patients	75	4	15	37	23	15	6
Urine							
infection confined to lower tract	29	7	10	34·5	34·5	7	7
infection of upper tract	19	0	16	16	21	26	21

Data from Brooks (1976).

in the proportion of strains which exhibited all (a score of 5) or most of the properties, but despite the use of several factors the overlap between the groups was still considerable.

Further refinement, using cluster analysis of all the properties examined, indicates that there is a reasonably well defined group of strains responsible for upper tract infection, but even combining all the properties by sophisticated methods of analysis fails to establish an unequivocal distinction between strains that invade the urinary tract and those which remain benignly in the faeces.

HOST DEFENCES

It seems inevitable that ranged against any properties required by the organism to invade the urinary tract are properties which confer on the patient the capacity to resist each step in the genesis of infection: colonisation of the anterior urethra, transfer of colonising organisms to the bladder and multiplication of transferred organisms in the urinary tract. So far, we are in no position to elucidate the host factors that determine introital colonisation, any more than we can define the micro-environmental determinants of surface colonisation elsewhere in the body, but there is one mechanism by which patients eliminate organisms transferred to their bladders which is readily accessible to study. This is the process of dilution and discharge of bladder bacteria which results from the constant addition of sterile ureteric urine to the infected bladder and the subsequent discharge of most of the diluted organisms at the next micturition.

The efficacy of this process can be demonstrated by asking patients with urinary infection to drink about 300 ml of water and empty the bladder as completely as possible every hour. Tested in this way, patients fall into fairly well defined groups in relation to the rate at which the concentration of bacteria falls in the successive hourly samples. In one group (Fig. 1.1A) the concentration of urinary bacteria falls rapidly over the first three or four hours and in some cases to below the level of 10^3 organisms per ml which is detected by standard laboratory methods. In a proportion of these patients the organisms do not reappear and these patients no doubt constitute the minority who are capable of promptly eradicating their own infection with the aid of diuresis.

The second group of patients (Fig. 1.1B) similarly reduce their bacterial counts quite dramatically over the first few hours to below the conventional level of 'significant bacteriuria' (10^5 per ml) but the concentration of organisms in the voided samples then remains fairly constant, usually hovering between 10^4 and 10^5 organisms per ml. When the patients cease drinking and emptying