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## Penicillinase-producing *Neisseria gonorrhoeae* in Great Britain, 1977-81: alarming increase in incidence and recent development of endemic transmission

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### Abstract

Since penicillinase-producing *Neisseria gonorrhoeae* appeared five years ago in West Africa and South-east Asia reported cases have doubled annually in Great Britain, primarily as a result of increasing importation. Importation of penicillinase-producing *Neisseria gonorrhoeae* has increased exponentially because dramatic expansion of these strains in their regions of origin has led to increasing infection of male air travellers. From 1977 to 1980 infections acquired in Great Britain played only a minor part in the exponential increase. During 1981 the number of indigenous cases increased much more rapidly than imported cases, indicating that these strains have become truly endemic in Great Britain.

Currently, identification of patients at high risk and initial treatment with penicillinase-resistant antibiotics offers the best hope of containing the strains. The emergence and rapid spread of penicillinase-producing *Neisseria gonorrhoeae* shows the international consequences of the abuse of antibiotics.

### Introduction

In 1976 strains of *Neisseria gonorrhoeae* appeared in West Africa and South-east Asia containing plasmids which coded for penicillin-splitting enzymes ( $\beta$ -lactamases) similar to those found in *Escherichia coli* and *Haemophilus influenzae*. Their ability to spread internationally was illustrated by initial case reports from London<sup>1</sup> and California<sup>2</sup> and by a large epidemic in Liverpool.<sup>3</sup> In a few years they were well established in their regions of origin and had spread worldwide.<sup>4</sup> This continuing process threatens to render ineffective the current treatment for gonorrhoea with penicillins. Effective, alternative regimens are either more expensive or more complicated. Techniques to control the spread of these strains are urgently needed but require an understanding of how they are spreading. Great Britain is a uniquely suitable place for studying this process for three reasons. Firstly, the system of specialised, hospital-based clinics for sexually transmitted diseases with full microbiological support ensures that most cases are detected. Secondly, a voluntary system of reporting has allowed the Communicable Diseases Surveillance Centre to monitor the epidemiology of the disease since 1977. Finally, direct airline connections from both Asia and Africa have resulted in importation of the strains originating in both endemic areas. Thus, the epidemiology of these two types of penicillinase-producing *Neisseria gonorrhoeae* can be compared under similar conditions of importation, detection, and reporting. We have analysed the epidemiology of the disease in Great Britain based on data reported to the Communicable Diseases Surveillance Centre and have provided practical advice on their detection and treatment.

### Methods

A reporting system for penicillinase-producing *Neisseria gonorrhoeae* in the United Kingdom was started in 1977 by the Communicable Disease Surveillance Centre, Colindale. Clinical data (age, sex, and

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source of infection) and location of patients were either reported directly to the centre or accompanied isolates forwarded to the Venereal Diseases Reference Laboratory at the London Hospital. We examined the distribution by age and sex of imported and indigenous cases based on all cases reported from 1977 to 1981 inclusive. A similar distribution of all cases of gonorrhoea for 1979 was constructed from data in the annual report of the chief medical officer of the Department of Health and Social Security. Distributions by age and sex of airline travellers between Great Britain and three countries endemic for penicillinase-producing *Neisseria gonorrhoeae* were constructed from data collected by the Department of Trade for the International Passenger Inquiry. The total number of cases for England of gonorrhoea and gonorrhoea acquired abroad were obtained each year from data routinely reported to the DHSS. The number of air passengers travelling between Great Britain and areas and countries endemic for penicillinase-producing *Neisseria gonorrhoeae* is published annually as *Civil Aviation Authority Annual Statistics*.

## Results

### INCIDENCE AND SOURCES IN GREAT BRITAIN

Reported cases of penicillinase-producing *Neisseria gonorrhoeae* in Great Britain have risen exponentially (doubled annually) since 1977 (table I). Until 1981 this rise had resulted primarily from cases directly imported (one-half) or contracted from imported cases (one-ninth). About one-quarter were indigenous cases (consort in United Kingdom) which were not linked to an imported case. The constant ratio (2:1) of imported to indigenous cases suggests that from 1977 to 1980 increasing importation, not sustained transmission within the country, was the driving force behind the enormous increase in incidence.

In 1981 the source of penicillinase-producing *Neisseria gonorrhoeae* in Great Britain began to shift from importation to endemic transmission. From July to December, more cases were acquired within the country than were imported (fig 1). The ratio of imported to indigenous cases dropped from 2:1 (1977-80) to nearly 1:1 (1981). Between 1980 and 1981, indigenous cases increased by 230% while imported cases increased by only 53%. The system of reporting the origin of penicillinase-producing *Neisseria gonorrhoeae* did not change

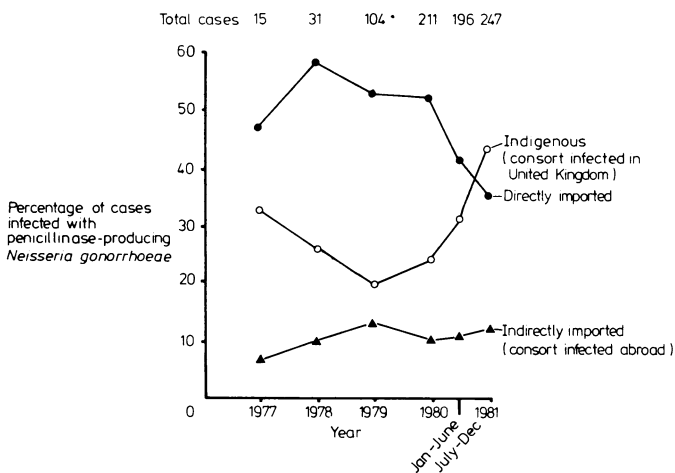


FIG 1—Percentage of total cases of penicillinase-producing *Neisseria gonorrhoeae* from 1977 to 1981 that were directly imported, indirectly imported (consort infected abroad), or indigenous (consort infected in United Kingdom).

during this period. The dramatic expansion of indigenous cases from 23% of all cases from 1977 to the end of 1980 to 43% in the second half of 1981 suggests that endemic transmission on a large scale is occurring for the first time in Great Britain.

### CHARACTERISTICS OF PEOPLE INFECTED

We believe most penicillinase-producing *Neisseria gonorrhoeae* are imported by male airline passengers recently infected in endemic areas. Directly imported strains have been found predominantly in men (9:1), but indigenous disease, like other strains of gonorrhoea in Great Britain, is divided nearly equally between the sexes (1.7:1). The incubation period of gonorrhoea (mean 3-5 days) and the slow and infrequent rail or sea connections to the endemic areas make air travel the only plausible mode of importation. Both men and women who import penicillinase-producing *Neisseria gonorrhoeae* are typically older than persons infected with indigenous penicillinase-producing *Neisseria gonorrhoeae* and older than patients with gonorrhoea in Great Britain (fig 2). The predominance of men and the age distribution of those importing penicillinase-producing *Neisseria gonorrhoeae* may be explained in part by more frequent travel to endemic areas by men (2:1) and by older people (fig 3). Since older men travel more often to endemic regions than other groups in the population, they are more likely to be exposed to penicillinase-producing *Neisseria gonorrhoeae* than younger men and women.

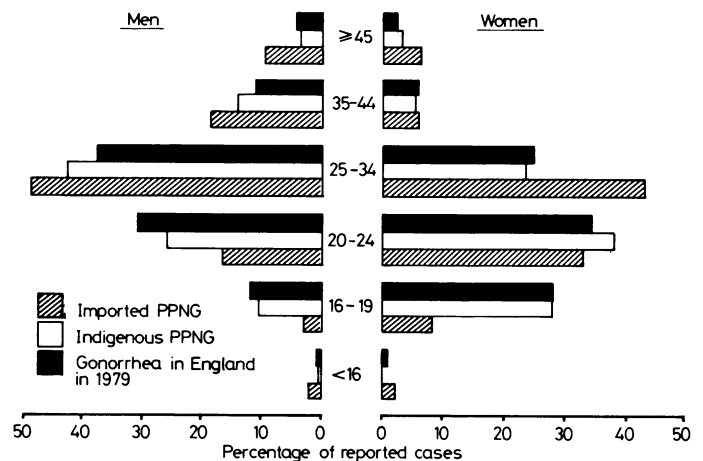


FIG 2—Distribution by age and sex of cases of imported and indigenous penicillinase-producing *Neisseria gonorrhoeae* in Great Britain for 1977-81 and of all cases of gonorrhoea in England for 1979.

Imported PPNG v all cases  $\chi^2 = 48.5$  ( $p < 0.001$ ) for men and 16.2 ( $p < 0.005$ ) for women. No significant difference in age between those with indigenous PPNG and all cases of gonorrhoea. Distribution by age and sex of cases from each endemic area (data not shown) did not differ significantly.

### GEOGRAPHICAL ORIGINS OF STRAINS IMPORTED INTO GREAT BRITAIN

Most penicillinase-producing *Neisseria gonorrhoeae* reach Great Britain from the two primary endemic regions as shown in table II.<sup>5</sup> A small, but growing, percentage of penicillinase-producing *Neisseria gonorrhoeae* are imported through non-endemic areas such as Europe. The validity of using reported geographical origin to classify the probable plasmid type was established in a recent study by Jephcott, Dickgiesser, and McClean.<sup>6</sup> They found that plasmid size correlated

TABLE I—No (%) of cases of infection with penicillinase-producing *Neisseria gonorrhoeae* reported in Great Britain\* from 1977 to 1981

	1977	1978	1979	1980	Jan-June 1981	July-Dec 1981	Total 1981	Total 1977-1981
Directly imported	7 (47)	18 (58)	55 (53)	110 (52)	80 (41)	88 (36)	168 (38)	358 (45)
Imported by consort	1 (7)	3 (10)	13 (13)	21 (10)	20 (10)	26 (11)	46 (10)	84 (10)
Consort in Great Britain	5 (33)	8 (26)	21 (20)	50 (24)	60 (31)	105 (43)	165 (37)	249 (31)
Unknown	2 (1.3)	2 (6)	15 (14)	30 (14)	36 (18)	28 (11)	64 (14)	113 (14)
Total	15	31	104	211	196	247	443	804

\*Includes two cases from Dublin and one from Northern Ireland.

perfectly with reported origin. All 14 Asian strains contained the 4.4 megadalton plasmid which originated in the Far East. Six African strains contained the 3.2 megadalton plasmid endemic in West Africa. Strains acquired in Britain were equally divided (seven African and eight Asian) between the two types. This suggests that both plasmid types spread with similar efficiency within Great Britain.

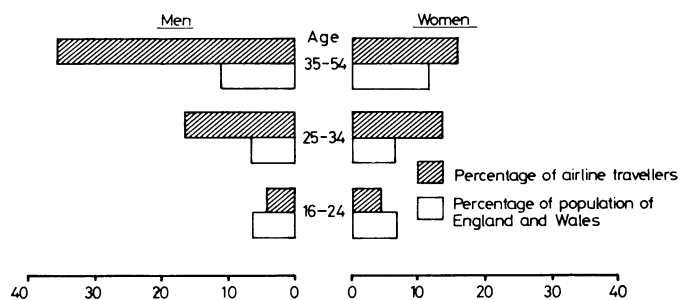


FIG 3—Distribution by age and sex of airline travellers from three countries endemic for penicillinase-producing *Neisseria gonorrhoeae* (Nigeria, Ghana, and Singapore) and of the population of England and Wales.

TABLE II—Geographical origins of 358 cases of penicillinase-producing *Neisseria gonorrhoeae* imported into Great Britain\* from 1977 to 1981

	1977	1978	1979	1980	1981	Total imported	Percentage of imported cases
Far East	2	7	31	49	79	168	47
West Africa	5	9	17	37	54	122	34
Europe	0	0	4	15	20	39	11
Others	0	2	3	9	15	29	8
Total	7	18	55	110	168	358	100

\*Includes two cases from Dublin and one from Northern Ireland.

#### FACTORS PROMOTING IMPORTATION

Increased importation of penicillinase-producing *Neisseria gonorrhoeae* could result from a general increase in importation of gonorrhoea, in travel to endemic areas, or in prevalence in endemic areas. Cases of gonorrhoea imported into the United Kingdom have increased by 24% from 1977 to 1980 (table III). During this period, penicillinase-

TABLE III—Importation of gonorrhoea into the United Kingdom, 1977-1980

	1977	1978	1979	1980
Total gonorrhoea:	65 917	63 523	61 556	60 772
Men	41 524	40 022	39 168	38 206
Women	24 393	23 501	22 388	22 566
Imported gonorrhoea:	2 144	2 073	2 568	2 447
Men	1 845	1 826	2 056	2 065
Women	299	247	512	382
% Total gonorrhoea that is imported	3.25	3.26	4.17	4.03
Imported PPNG:	7	18	55	110
Men			47	101
Women			8	9
% Imported gonorrhoea that is PPNG	0.33	0.87	2.14	4.50
% Imported gonorrhoea that is PPNG in men			2.28	4.89
% Imported gonorrhoea that is PPNG in women			1.56	2.35

PPNG = Penicillinase-producing *Neisseria gonorrhoeae*.

producing *Neisseria gonorrhoeae* increased 13-fold from 0.33% to 4.5% of all imported cases of gonorrhoea. Airline travel between Great Britain and West Africa increased by 60% from 1979 to 1981 (table IV). South-east Asian arrivals and departures increased by only 5% and travel to and from Thailand—from which 56% of all Asian cases came—decreased by 5% during the same period. Thus, neither importation of gonorrhoea nor travel to endemic areas have increased sufficiently to account for more than a small fraction of the enormous increase in the penicillinase-producing *Neisseria gonorrhoeae*.

Data on the prevalence of penicillinase-producing *Neisseria*

TABLE IV—Air travel to and from regions and leading countries endemic for penicillinase-producing *Neisseria gonorrhoeae*. Figures are numbers of passengers (in thousands) between British airports and designated endemic areas

	West Africa (Nigeria and Ghana)		South-east Asia (Thailand, Philippines, Singapore)	
	Total	Nigeria	Total	Thailand
1979	350	265	653	90
1980	425	340	676	99
1981*	562	412	687	85
% Change 1979-1981	+60	+55	+5	-5

\*Projected from figures for January-June 1981.

*gonorrhoeae* in endemic areas are sparse, but suggest that endemic areas in Asia and Africa are expanding. Certain populations of sexually active, regularly screened "hostesses" in the Philippines have maintained a prevalence of about 30% for the past five years.<sup>4</sup> In contrast, other clinics report increasing prevalences. In Singapore, a large clinic reported an increase from 0.29% in 1977 to 19.2% in 1981.<sup>7</sup> In Bangkok, Thailand, the percentage of penicillinase-producing *Neisseria gonorrhoeae* in men with urethritis has increased from 8.6% in early 1978 to 28.8% in early 1980.<sup>8</sup> In Nigeria, prevalence rose from 3% in 1979 to 20% in 1980.<sup>9</sup> The striking expansion of these strains within endemic areas of Africa and Asia is probably the major reason that the disease doubled annually in Great Britain from 1977 to 1980.

#### Discussion

A fundamental change in the epidemiology of penicillinase-producing *Neisseria gonorrhoeae* in Great Britain occurred during 1981. From 1977 to 1980, importation of the disease from endemic areas by male air travellers was the major cause of the dramatic increase in incidence. In 1981, it assumed a truly endemic pattern of spread, with cases acquired within the country dominating. The reason for this change in pattern is not clear.

Initially, these strains of gonococci themselves or their plasmids may not have been transmitted very efficiently in Great Britain for several reasons. These strains have evolved in areas where self-prescribed penicillin prophylaxis for gonorrhoea is common.<sup>4,10</sup> In the absence of this selective pressure they may sometimes spontaneously lose their plasmids.<sup>3</sup> Secondly, the imported gonococcal strains harbouring the penicillinase plasmid may not spread as efficiently in Great Britain as indigenous gonococcal strains. In addition, vigorous control measures such as accelerated and persistent tracing of contacts may have contained their transmission. Thus, indigenous penicillinase-producing *Neisseria gonorrhoeae* found in Great Britain before 1981 may not have been self-sustaining, but may have arisen when the imported penicillinase-producing *Neisseria gonorrhoeae* passed for a few generations before they were eliminated as a result of spontaneous loss of their plasmids, decreased infectivity, or treatment with appropriate antibiotics.

Other countries outside the endemic areas have reported increased prevalence of these strains of gonococci and patterns of spread have varied. In the Netherlands, the fraction of the disease contacted outside the country rapidly declined from 11 out of 13 (85%) in 1976-7 to 30 of 271 (11%) in 1979.<sup>11</sup> This increase of indigenous as compared with imported cases implies that prolonged, sustained transmission of penicillinase-producing *Neisseria gonorrhoeae* occurred in the Netherlands soon after the strains were first imported. Plasmid analysis and clinical data both show that almost all penicillinase-producing *Neisseria gonorrhoeae* were of Asian origin until 1979. In September 1980 a sharp increase in gonorrhoea occurred in Amsterdam associated with the appearance of gonococci containing the 3.2 megadalton (African) plasmid associated with a 24 megadalton transfer plasmid.<sup>12</sup> The coincidence of these developments suggests that the transfer plasmid considerably enhanced the spread of the penicillinase plasmid. Two cases of combined "African" and

transfer plasmids were recently reported from Great Britain.<sup>13</sup> The combination of Asian plasmids with transfer plasmids is the rule in Great Britain and elsewhere, however,<sup>12, 13</sup> but has not led to disproportionately rapid spread of the Asian plasmid here.

The patterns in the United States vary geographically and have taken several forms.<sup>14</sup> Most cases have been reported from the west coast and nearly all were associated with the Asian plasmid. From 1976 to 1979 almost half of the cases could be traced to importation. In the summer of 1980 an endemic focus in Los Angeles county was identified during an outbreak of penicillinase-producing *Neisseria gonorrhoeae* in which sustained transmission occurred in chains of up to six people.<sup>15</sup> An outbreak in Louisiana affected 28 people in eight "apparently unrelated" chains of transmission and no imported cases.<sup>16</sup> This outbreak was controlled by routine testing of all gonococci and vigorous tracing of contacts. A similar outbreak in Liverpool in 1976 affected 76 people over nine months and was similarly controlled.<sup>3</sup> Thus, experience in Liverpool, America, and the Netherlands before 1981 illustrated the potential for endemic spread—that is, prolonged and sustained transmission—of penicillinase-producing *Neisseria gonorrhoeae* in Western countries. Vigorous efforts to control local spread had sometimes been successful, but increasing importation, evolution of new combinations of plasmids, or spread of plasmids to indigenous gonococci apparently can overwhelm these efforts. The sudden increase in indigenous cases in 1981 suggests that these processes have now subverted the measures which had previously controlled endemic spread in Great Britain.

The shift toward endemic transmission of penicillinase-producing *Neisseria gonorrhoeae* has created the potential for rapidly increasing prevalences in the near future. Most areas of Great Britain have a low prevalence (<1%), though some urban clinics are approaching 5%. In areas of low prevalence (<5%), control of the disease is directed at high risk groups—for example, patients failing to respond to penicillin, contacts of known cases, and travellers from endemic areas. For such patients gonococcal isolates should be immediately screened for penicillinase production, penicillinase-resistant antibiotics should be given, and intensive tracing and treatment of contacts pursued. We suggest that in cases of uncomplicated anogenital infection spectinomycin, 2 g intramuscularly, should be the treatment of choice. Alternatively, patients could be given probenecid, 1 g orally, followed by either cefoxitin 2 g, cefuroxime 1.5 g, or cefotaxime 0.5 g, all given intramuscularly and diluted in 4 ml of 0.5% lignocaine to decrease pain. In cases of pharyngeal infection nine co-trimoxazole tablets should be taken all at once every day for five days. A rise to more than 5% in the local prevalence of indigenous disease would give warning that these control measures were inadequate. In such circumstances, we recommend that all gonococcal isolates be screened and all patients be treated initially with a regimen described above.<sup>4, 17-19</sup> Currently, physicians should establish the geographical origin of all cases of possible gonorrhoea for two reasons: firstly, to identify patients at high risk and, secondly, to keep track of the prevalence of penicillinase-producing *Neisseria gonorrhoeae* in locally-acquired gonorrhoea. The measures outlined offer the best hope of containing the disease. By reporting it directly to the Communicable Diseases Surveillance Centre or when possible forwarding isolates and clinical information to the Venereal Disease Reference Laboratory (The London Hospital, Ashfield Street, Whitechapel, London E11 BB), the success of these measures can be monitored nationally. If continuing importation and endemic spread further increase the prevalence of these strains, penicillins will no longer be appropriate initial treatment for gonorrhoea in Great Britain.

Penicillinase-producing *Neisseria gonorrhoeae* arose in areas where self-administered prophylaxis and treatment of gonorrhoea with penicillins is widely practised.<sup>4, 10</sup> They have become endemic in Great Britain despite a sophisticated system for treating sexually transmitted diseases and a high level of control over the sale of antibiotics. This experience suggests these strains will eventually constitute an appreciable fraction of gonococci

throughout the world. The emergence and spread of the strains shows that abuse of antibiotics in any part of the world can have serious international consequences.

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SHEPHERD'S PURSE is called Whoremans' Permacety, Shepherd's Scrip, Shepherd's Pounce, Toywort, Pickpurse, and Casewort.

The root is small, white, and perishes every year. The leaves are small and long, of a pale green colour, and deeply cut in on both sides, among which spring up a stalk which is small and round, containing small leaves upon it even to the top. The flowers are white and very small; after which come the little cases which hold the seed, which are flat, almost in the form of a heart. They are frequent in this nation, almost by every path-side. They flower all the Summer long; nay some of them are so fruitful, that they flower twice a year.

It is under the dominion of Saturn, and of a cold, dry, and binding nature, like to him. It helps all fluxes of blood, either caused by inward or outward wounds; as also flux of the belly, and bloody flux, spitting blood, and bloody urine, stops the terms in women; being bound to the wrists of the hands, and the soles of the feet, it helps the yellow jaundice. The herb being made into a poultice, helps inflammations and St Anthony's fire. The juice being dropped into the ears, heals the pains, noise, and mutterings thereof. A good ointment may be made of it for all wounds, especially wounds in the head. (Nicholas Culpeper (1616-54) *The Complete Herbal*, 1850.)