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The epidemiology of adenovirus infections in Greater Manchester, UK 1982–96

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SUMMARY

Data relating to 3313 adenovirus isolates from patients in Greater Manchester, UK between 1982 and 1996 were analysed using χ^2 tests and 95% confidence intervals. Of the 3098 isolates that were typed, 18·6% were serotype 2, 14·9% serotype 3, 12·1% serotype 1 and 10·9% serotype 41. There was evidence of a seasonal occurrence of serotype 7 (March–August), serotype 2 (January–April), serotype 4 (June–August) and subgenus F (September–November). Children less than 5 years old were the most common group of patients with adenovirus infection (61·3%) compared to 24·2% for adults and only 5·6% for school children (5–15 years). Gastric symptoms were the most common amongst infants (47·6%) followed by respiratory (27·5%) and general symptoms (12·9%). In adults, the overwhelming clinical condition was conjunctivitis (88·9%). Despite the traditional association with adenoviruses, remarkably few cases of pharyngoconjunctival fever were recorded (1·7%).

INTRODUCTION

Human adenoviruses are divided into 49 serotypes which are grouped into 6 subgenera, A–F [1, 2]. The main epidemiological characteristics of these viruses have been established by a number of both large and small-scale studies from various parts of the world. In the United States during the 1960s, 'The Virus Watch' programme in several cities included the surveillance of adenovirus infection [3]. A controlled study, conducted in the period 1957–67, in a Washington children's hospital also yielded a large body of information on the association of adenovirus with respiratory tract disease [4, 5]. Both of these studies attempted to estimate the true frequency of infection by including data from the testing of healthy subjects.

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Surveys of adenovirus isolates from symptomatic patients include a global review of adenovirus epidemiology from an analysis of 25000 WHO reports for 1967–76 [6]. Later studies have demonstrated the causal relationship of adenovirus types 40 and 41 to infantile gastroenteritis [7, 8] and more recently provided further information on the epidemiological features of adenoviruses in respiratory tract infections [9, 10]. The molecular epidemology of the full range of subgenera isolated in the Stockholm area during 1987–92 has also been reported [11].

We collated data on adenovirus isolates from patients in Greater Manchester, UK collected over the 14 year period 1982–96. The aim of this study was to determine the association of the various adenovirus serotypes with age and sex of the patient, their occurrence in different clinical symptoms and the temporal frequency of their isolation in a large city-centre hospital of a developed country. Also, epidemio-

logical information of this type is increasingly difficult to obtain. In the UK, for example, the Public Health Laboratory Service no longer provides reagents for adenovirus serotype identification and the economics of hospital diagnostic virology services often preclude the purchase of reagents from other sources.

METHODS

Patients and specimens

The patients included in this study were from the Greater Manchester conurbation (population, 4 million). All age groups were represented and included both hospitalized patients and a small number (less than 1%) of non-hospital patients who had symptoms severe enough to warrant the taking of diagnostic specimens. These specimens included eye swabs, throat swabs, faeces, nasopharyngeal aspirates, urine, bronchoalveolar lavage and occasional post mortem tissue.

Clinical information

The clinical categories used in this study encompassed the following symptoms reported by the clinicians on the diagnostic request cards. Eye symptoms; red/sticky/gritty/sore eye, conjunctivitis, follicular conjunctivitis, keratoconjunctivitis. Respiratory symptoms; upper/lower respiratory tract infection, pneumonia, cough, wheeze, tonsillitis, apnoea, tachypnoea. Gastric symptoms; diarrhoea, vomiting, abdominal pain, poor feeding, melaena. General symptoms only; fever, rash, fits, general malaise, lymphadenopathy, other viral infections. General symptoms also occurred frequently with eye, respiratory and gastric symptoms.

Virus isolation and identification

For adenovirus isolation, specimens were routinely inoculated on to monolayer cultures of human embryo fibroblasts, primary rhesus monkey kidney, Vero and Hep-2 cells. Serotypes were identified by neutralization tests [12, 13] using reagents obtained from the Laboratory of Microbiological Reagents, Public Health Laboratory Service, Colindale, London, UK. Adenoviruses not typed successfully by neutralization were analysed by restriction endonuclease analysis of their DNA as previously described [13, 14]. Until June 1984, a presumptive diagnosis of subgenus F was made if adenovirus particles observed in faecal samples by electron microscopy could not be recovered by cell culture [15, 16]. From June 1984, immune electron microscopy (IEM) was used, initially with polyclonal antisera to distinguish subgenus F from other serotypes [17]. Later, monoclonal antibodies were developed to differentiate between types 40 and 41 in the IEM method [18]. When the monoclonal antibodies gave equivocal results, the type was confirmed by restriction endonuclease analysis [19].

Data collection

Data was collated by manual review of the laboratory's weekly reports of virus isolation submitted to the Communicable Disease Surveillance Centre, Public Health Laboratory Service, Colindale, London, UK and assembled in a Microsoft™ Access™ database held on a personal computer. During the 14 years of this study, data on 3313 adenovirus isolates were accumulated and included representatives of all 6 subgenera.

Statistical methods

The frequencies with which adenoviruses fell into the age, sex and clinical disease categories were compared using contingency table (χ^2) tests. Significant test results were evaluated in detail by examination of the 95% confidence intervals for each category.

RESULTS

Yearly occurrence of adenoviruses

Fluctuations in the yearly occurrence of adenoviruses are shown in Table 1 where only data available from complete years are shown. Many serotypes were isolated too infrequently to draw meaningful conclusions, but the more common isolates did show some differences. In the case of subgenus B, serotype 3 was very uncommon in 1985 and 1986 and underrepresented in 1983, 1989 and 1995 although there were no years showing a significant peak of isolations. On the other hand, the serotype 7 was particularly prevalent in 1984 and significant numbers were isolated in 1990 and 1992 but relatively few were found in the other years. There was little evidence for annual variation amongst subgenus C although serotype 5 was less common in 1993–5.

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Table 1. *Yearly occurrence of adenoviruses isolated from patients in Greater Manchester, UK, 1983–95*

Subgenus and serotype	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Total
A														
12,18,31	0	2 (0·7) [−0·3, 1·6]	1 (0·5) [−0·5, 1·5]	2 (0·9) [−0·3, 2·1]	0	7 (2·6) [0·7, 4·5]	6 (2·7) [0·6, 4·8]	7 (2·5) [0·7, 4·3]	4 (1·4) [0·0, 2·7]	0	4 (2·1) [0·1, 4·1]	5 (2·6) [0·3, 4·8]	6 (4·8) [1·1, 8·5]	44
B														
3	16 (11·6) [6·3, 16·9]	42 (14·3) [10·3, 18·3]	4 (2·0) [0·1, 4·0]	7 (3·1) [0·8, 5·3]	44 (22·3) [16·5, 28·2]	52 (19·2) [14·5, 23·9]	20 (9·0) [5·2, 12·7]	48 (16·9) [12·5, 21·3]	51 (17·3) [13·0, 21·6]	41 (15·5) [11·2, 19·9]	41 (21·2) [15·5, 27·0]	50 (25·5) [19·4, 31·6]	11 (8·8) [3·8, 13·8]	427
7	10 (7·2) [2·9, 11·6]	72 (24·6) [19·6, 29·5]	22 (11·2) [6·8, 15·6]	5 (2·2) [0·3, 5·1]	3 (1·5) [−0·2, 3·2]	2 (0·7) [−0·3, 1·8]	7 (3·1) [0·9, 5·4]	35 (12·3) [8·5, 16·1]	17 (5·8) [3·1, 8·4]	32 (12·1) [8·2, 6·1]	7 (3·6) [1·0, 6·3]	10 (5·1) [2·0, 8·2]	4 (3·2) [0·1, 6·3]	226
11, 14, 16, 21, 34/35	0	2 (0·7) [−0·3, 1·6]	5 (2·6) [0·3, 4·8]	3 (1·3) [−0·2, 2·8]	1 (0·5) [−0·5, 1·5]	3 (1·1) [−0·1, 2·4]	1 (0·4) [−0·4, 1·3]	4 (1·4) [0·0, 2·8]	3 (1·0) [−0·1, 2·2]	2 (0·8) [−0·3, 1·8]	1 (0·5) [−0·5, 1·5]	0	0	25
C														
1	17 (12·3) [6·8, 17·8]	41 (14·0) [10·0, 18·0]	36 (18·4) [12·9, 23·8]	40 (17·5) [12·5, 22·4]	21 (10·7) [6·4, 15·0]	21 (7·7) [4·6, 10·9]	38 (17·0) [12·1, 22·0]	37 (13·0) [9·1, 16·9]	31 (10·5) [7·0, 14·0]	36 (13·6) [9·5, 17·8]	20 (10·4) [6·1, 14·7]	15 (7·7) [3·9, 11·4]	9 (7·2) [2·7, 11·7]	362
2	27 (19·6) [12·9, 26·2]	41 (14·0) [10·0, 18·0]	43 (21·9) [16·1, 27·7]	56 (24·5) [18·9, 30·0]	32 (16·2) [11·1, 21·4]	55 (20·3) [15·5, 25·1]	42 (18·8) [13·7, 24·0]	59 (20·8) [16·1, 25·5]	48 (16·3) [12·1, 20·5]	47 (17·8) [13·2, 22·4]	35 (18·1) [12·7, 23·6]	49 (25·0) [18·9, 31·1]	19 (15·2) [8·9, 21·5]	553
5	13 (9·4) [4·5, 14·3]	16 (5·5) [2·9, 8·1]	17 (8·7) [4·7, 12·6]	34 (14·8) [10·2, 19·5]	22 (11·2) [6·8, 15·6]	30 (11·1) [7·3, 14·8]	11 (4·9) [2·1, 7·8]	8 (2·8) [0·9, 4·7]	15 (5·1) [2·6, 7·6]	9 (3·4) [1·2, 5·6]	5 (2·6) [0·3, 4·8]	4 (2·0) [0·1, 4·0]	4 (3·2) [0·1, 6·3]	188
6	2 (1·4) [−0·5, 3·4]	11 (3·8) [1·6, 5·9]	6 (3·1) [0·6, 5·5]	3 (1·3) [−0·2, 2·8]	0	1 (0·4) [−0·4, 1·1]	1 (0·4) [−0·4, 1·3]	3 (1·1) [−0·1, 2·2]	7 (2·4) [0·6, 4·1]	2 (0·8) [−0·3, 1·8]	5 (2·6) [0·3, 4·8]	8 (4·1) [1·3, 6·9]	4 (3·2) [0·1, 6·3]	53
D														
8, 19, 37	7 (5·1) [1·4, 8·7]	6 (2·0) [0·4, 3·7]	5 (2·6) [0·3, 4·8]	3 (1·3) [−0·2, 2·8]	1 (0·5) [−0·5, 1·5]	6 (2·2) [0·5, 4·0]	1 (0·4) [−0·4, 1·3]	1 (0·4) [−0·3, 1·0]	21 (7·1) [4·2, 10·1]	3 (1·1) [−0·1, 2·4]	9 (4·7) [1·7, 7·6]	4 (2·0) [0·1, 4·0]	12 (9·6) [4·4, 14·8]	79
9, 10	6 (4·3) [0·9, 7·8]	1 (0·3) [−0·3, 1·0]	0	1 (0·4) [−0·4, 1·3]	0	3 (1·1) [−0·1, 2·4]	0	20 (7·0) [4·1, 10·0]	20 (6·8) [3·9, 9·6]	31 (11·7) [7·9, 15·6]	19 (9·8) [5·6, 14·0]	4 (2·0) [0·1, 4·0]	7 (5·6) [1·6, 9·6]	112
17, 23, 26, 27, 39, 44	0	0	0	0	0	2 (0·7) [−0·3, 1·8]	2 (0·9) [−0·3, 2·1]	1 (0·4) [−0·3, 1·0]	0	1 (0·4) [−0·4, 1·1]	1 (0·5) [−0·5, 1·5]	1 (0·5) [−0·5, 1·5]	0	8
E														
4	1 (0·7) [−0·7, 2·1]	5 (1·7) [0·2, 3·2]	4 (2·0) [0·1,4·0]	16 (7·0) [3·7, 10·3]	30 (15·2) [10·2, 20·2]	22 (8·1) [4·9, 11·4]	26 (11·7) [7·4, 15·9]	30 (10·6) [7·0, 14·1]	28 (9·5) [6·1, 12·8]	23 (8·7) [5·3, 12·1]	6 (3·1) [0·6, 5·5]	6 (3·1) [0·6, 5·5]	16 (12·8) [6·9, 18·7]	213
F														
40	0	2 (0·7) [−0·3, 1·6]	11 (5·6) [2·4, 8·8]	3 (1·3) [−0·2, 2·8]	4 (2·0) [0·1, 4·0]	14 (5·2) [2·5, 7·8]	19 (8·5) [4·9, 12·2]	12 (4·2) [1·9, 6·6]	12 (4·1) [1·8, 6·3]	18 (6·8) [3·8, 9·9]	7 (3·6) [1·0, 6·3]	5 (2·6) [0·3, 4·8]	3 (2·4) [−0·3, 5·1]	110
41	0	23 (7·8) [4·8, 10·9]	31 (15·8) [10·7, 20·9]	45 (19·7) [14·5, 24·8]	25 (12·7) [8·0, 17·3]	51 (18·8) [14·2, 23·5]	43 (19·3) [14·1, 24·5]	17 (6·0) [3·2, 8·7]	22 (7·5) [4·5, 10·5]	10 (3·8) [1·5, 6·1]	25 (13·0) [8·2, 17·7]	22 (11·2) [6·8, 15·6]	11 (8·8) [3·8, 13·8]	325
Untyped subgenus F	39 (28·3) [20·7, 35·8]	29 (9·9) [6·5, 13·3]	11 (5·6) [2·4, 8·8]	9 (3·9) [1·4, 6·4]	14 (7·1) [3·5, 10·7]	2 (0·7) [−0·3, 1·8]	6 (2·7) [0·6, 4·8]	2 (0·7) [−0·3, 1·7]	16 (5·4) [2·8, 8·0]	9 (3·4) [1·2, 5·6]	8 (4·1) [1·3, 7·0]	13 (6·6) [3·1, 10·1]	19 (15·2) [8·9, 21·5]	177
All subgenus F	39 (28·3) [20·7, 35·8]	54 (18·4) [14·0, 22·9]	53 (27·0) [20·8, 33·3]	57 (24·9) [19·3, 30·5]	43 (21·8) [16·1, 27·6]	67 (24·7) [19·6, 29·9]	68 (30·5) [24·5, 36·5]	31 (10·9) [7·3, 14·5]	50 (16·9) [12·7, 21·2]	37 (14·0) [9·8, 18·2]	40 (20·7) [15·0, 26·4]	40 (20·4) [14·8, 26·1]	33 (26·4) [18·7, 34·1]	612
Total	138	293	196	229	197	271	223	284	295	264	193	196	125	2904

* Number of isolates (% of all isolates in that year) [95% confidence interval]. $\chi^2(144) = 761{\cdot}97$; $P < 0{\cdot}001$.

Table 2. *Monthly occurrence of adenoviruses isolated from patients in Greater Manchester, UK, 1982–96*

Subgenus and serotype	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total	% of all isolates
A														
12, 18, 31	4 (1·5) [0·0, 3·0]	4 (1·3) [0·0, 2·6]	7 (2·1) [0·6, 3·6]	2 (0·7) [−0·3, 1·2]	1 (0·4) [−0·4, 1·2]	5 (1·9) [0·2, 3·5]	3 (1·1) [−0·1, 2·4]	6 (2·6) [0·5, 4·6]	4 (2·2) [0·1, 4·4]	2 (0·7) [−0·3, 1·7]	1 (0·5) [−0·4, 1·4]	5 (2·3) [0·3, 4·4]	44	1·4
B														
3	38 (14·3) [10·1, 18·6]	48 (15·9) [11·8, 20·0]	54 (16·1) [12·2, 20·1]	41 (13·9) [10·0, 17·9]	36 (14·2) [9·9, 18·5]	36 (13·5) [9·4, 17·6]	46 (17·2) [12·7, 21·8]	32 (13·9) [9·4, 18·3]	24 (13·4) [8·4, 18·4]	31 (11·3) [7·6, 15·1]	40 (18·3) [13·2, 23·5]	35 (16·4) [11·4, 21·3]	461	14·9
7	15 (5·7) [2·9, 8·4]	13 (4·3) [2·0, 6·6]	36 (10·7) [7·4, 14·1]	35 (11·9) [8·2, 15·6]	27 (10·7) [6·9, 14·5]	30 (11·3) [7·5, 15·1]	23 (8·6) [5·2, 12·0]	18 (7·8) [4·3, 11·2]	5 (2·8) [0·4, 5·2]	10 (3·6) [1·4, 5·9]	6 (2·8) [0·6, 4·9]	10 (4·7) [1·8, 7·5]	228	7·4
11, 14, 16, 21, 34/35	0	2 (0·7) [−0·3, 1·6]	1 (0·3) [−0·3, 0·9]	3 (1·0) [−0·1, 2·2]	3 (1·2) [−0·1, 2·5]	1 (0·4) [−0·4, 1·1]	2 (0·7) [−0·3, 1·8]	5 (2·2) [0·3, 4·0]	1 (0·6) [−0·5, 1·7]	4 (1·5) [0·0, 2·9]	1 (0·5) [−0·4, 1·4]	3 (1·4) [−0·2, 3·0]	26	0·8
C														
1	28 (10·6) [6·9, 14·3]	43 (14·2) [10·3, 18·2]	31 (9·3) [6·2, 12·4]	32 (10·9) [7·3, 14·4]	42 (16·6) [12·0, 21·2]	34 (12·8) [8·8, 16·8]	24 (9·0) [5·6, 12·4]	25 (10·8) [6·8, 14·8]	19 (10·6) [6·1, 15·1]	38 (13·9) [9·8, 18·0]	29 (13·3) [8·8, 17·8]	30 (14·0) [9·4, 18·7]	375	12·1
2	72 (27·2) [21·8, 32·5]	67 (22·2) [17·5, 26·9]	75 (22·4) [17·9, 26·9]	64 (21·8) [17·1, 26·5]	37 (14·6) [10·3, 19·0]	52 (19·5) [14·8, 24·3]	46 (17·2) [12·7, 21·8]	29 (12·6) [8·3, 16·8]	25 (14·0) [8·9, 19·0]	41 (15·0) [10·7, 19·2]	31 (14·2) [9·6, 18·9]	37 (17·3) [12·2, 22·4]	575	18·6
5	17 (6·4) [3·5, 9·4]	27 (8·9) [5·7, 12·2]	28 (8·4) [5·4, 11·3]	22 (7·5) [4·5, 10·5]	9 (3·6) [1·3, 5·8]	15 (5·6) [2·9, 8·4]	12 (4·5) [2·0, 7·0]	11 (4·8) [2·0, 7·5]	10 (5·6) [2·2, 9·0]	17 (6·2) [3·3, 9·1]	15 (6·9) [3·5, 10·2]	11 (5·1) [2·2, 8·1]	194	6·3
6	8 (3·0) [1·0, 5·1]	2 (0·7) [−0·3, 1·6]	12 (3·6) [1·6, 5·6]	7 (2·4) [0·6, 4·1]	4 (1·6) [0·0, 3·1]	2 (0·8) [−0·3, 1·8]	3 (1·1) [−0·1, 2·4]	0	3 (1·7) [−0·2, 3·6]	6 (2·2) [0·5, 3·9]	5 (2·3) [0·3, 4·3]	1 (0·5) [−0·4, 1·4]	53	1·7
D														
8, 19, 37	7 (2·6) [0·7, 4·6]	24 (7·9) [4·9, 11·0]	10 (3·0) [1·2, 4·8]	1 (0·3) [−0·3, 1·0]	1 (0·4) [−0·4, 3·1]	2 (0·8) [−0·3, 1·8]	4 (1·5) [0·0, 3·0]	3 (1·3) [−0·2, 2·8]	7 (3·9) [1·1, 6·8]	23 (8·4) [5·1, 11·7]	6 (2·8) [0·6, 4·9]	8 (3·7) [1·2, 6·3]	96	3·1
9, 10	15 (5·7) [2·9, 8·4]	6 (2·0) [0·4, 3·6]	6 (1·8) [0·4, 3·2]	8 (2·7) [0·9, 4·6]	14 (5·5) [2·7, 8·4]	9 (3·4) [1·2, 5·6]	12 (4·5) [2·0, 7·0]	9 (3·9) [1·4, 6·4]	8 (4·5) [1·4, 7·5]	12 (4·4) [2·0, 6·8]	8 (3·7) [1·2, 6·2]	8 (3·7) [1·2, 6·3]	115	3·7
17, 23, 26, 27, 39, 44	1 (0·4) [−0·4, 1·1]	1 (0·3) [−0·3, 1·0]	1 (0·3) [−0·3, 0·9]	2 (0·7) [−0·3, 1·6]	0	0	0	0	1 (0·6) [−0·5, 1·7]	2 (0·7) [−0·3, 1·7]	0	2 (0·9) [−0·4, 2·2]	10	0·3
E														
4	18 (6·8) [3·8, 9·8]	16 (5·3) [2·8, 7·8]	20 (6·0) [3·4, 8·5]	27 (9·2) [5·9, 12·5]	29 (11·5) [7·5, 15·4]	33 (12·4) [8·4, 16·4]	36 (13·5) [9·4, 17·6]	40 (17·3) [12·4, 22·2]	12 (6·7) [3·0, 10·4]	13 (4·7) [2·2, 7·3]	7 (3·2) [0·9, 5·6]	26 (12·1) [7·8, 16·5]	277	8·9
F														
40	4 (1·5) [0·0, 3·0]	11 (3·6) [1·5, 5·8]	12 (3·6) [1·6, 5·6]	11 (3·7) [1·6, 5·9]	3 (1·2) [−0·1, 2·5]	9 (3·4) [1·2, 5·6]	11 (4·1) [1·7, 6·5]	9 (3·9) [1·4, 6·4]	8 (4·5) [1·4, 7·5]	20 (7·3) [4·2, 10·4]	10 (4·6) [1·8, 7·4]	3 (1·4) [−0·2, 3·0]	111	3·6
41	21 (7·9) [4·7, 11·2]	27 (8·9) [5·7, 12·2]	26 (7·8) [4·9, 10·6]	26 (8·8) [5·6, 12·1]	29 (11·5) [7·5, 15·4]	21 (7·9) [4·7, 11·1]	23 (8·6) [5·2, 12·0]	34 (14·7) [10·1, 19·3]	36 (20·1) [14·2, 26·0]	41 (15·0) [10·7, 19·2]	36 (16·5) [11·6, 21·4]	17 (7·9) [4·3, 11·6]	337	10·9
Untyped subgenus F	17 (6·4) [3·5, 9·4]	11 (3·6) [1·5, 5·8]	16 (4·8) [2·5, 7·1]	13 (4·4) [2·1, 6·8]	18 (7·1) [3·9, 10·3]	17 (6·4) [3·5, 9·3]	22 (8·2) [4·9, 11·5]	10 (4·3) [1·7, 7·0]	16 (8·9) [4·8, 13·1]	14 (5·1) [2·5, 7·7]	23 (10·6) [6·5, 14·6]	18 (8·4) [4·7, 12·1]	195	6·3
All subgenus F	42 (15·8) [11·5, 20·2]	49 (16·2) [12·1, 20·2]	54 (16·1) [12·2, 20·1]	50 (17·0) [12·7, 21·3]	50 (19·8) [14·9, 24·7]	47 (17·7) [13·1, 22·3]	56 (21·0) [16·1, 25·9]	53 (22·9) [17·5, 28·4]	60 (33·5) [26·6, 40·4]	75 (27·4) [22·1, 32·7]	69 (31·7) [25·5, 37·8]	38 (17·8) [12·6, 22·9]	643	20·8
Total	265	302	335	294	253	266	267	231	179	274	218	214	3098	100

* Number of isolates (% of total of each month) [95% confidence interval]. $\chi^2(132) = 349{\cdot}59$; $P < 0{\cdot}001$.

Table 3. *Age distribution of patients with adenoviruses isolated in Greater Manchester, UK, 1982–96*

Subgenus and species	Age groups (years)					Total
	< 1	1–4	5–15	> 15	N/K	
A						
12, 18, 31	14 (31·8) [18·6, 47·6]	12 (27·3) [15·0, 42·8]	3 (6·8) [1·4, 18·7]	1 (2·3) [0·1, 12·0]	14 (31·8) [18·6, 47·6]	44
B						
3	47 (10·2) [7·6, 13·3]	126 (27·3) [23·3, 31·7]	58 (12·6) [9·7, 16·0]	199 (43·2) [38·6, 47·8]	31 (6·7) [4·6, 9·4]	461
7	52 (22·8) [17·5, 28·8]	69 (30·3) [24·4, 36·7]	30 (13·2) [9·1, 18·3]	65 (28·5) [22·7, 34·8]	12 (5·3) [2·8, 9·0]	228
11, 14, 16, 21, 34/35	1 (3·9) [0·1, 19·6]	2 (7·7) [1·0, 25·1]	6 (23·1) [9·0, 43·7]	9 (34·6) [17·2, 55·7]	8 (30·8) [14·3, 51·8]	26
C						
1	181 (48·3) [43·1, 53·5]	139 (37·1) [32·2, 42·2]	13 (3·5) [1·9, 5·9]	15 (4·0) [2·3, 6·5]	27 (7·2) [4·8, 10·3]	375
2	253 (43·9) [39·8, 48·1]	237 (41·2) [37·1, 45·3]	23 (4·0) [2·6, 5·9]	25 (4·3) [2·8, 6·3]	38 (6·6) [4·7, 8·9]	576
5	87 (44·9) [37·7, 52·1]	74 (38·1) [31·3, 45·4]	4 (2·1) [0·6, 5·2]	14 (7·2) [4·0, 11·8]	15 (7·7) [4·4, 12·4]	194
6	22 (41·5) [28·1, 55·9]	19 (35·9) [23·1, 50·2]	4 (7·6) [2·1, 18·2]	5 (9·4) [3·1, 20·7]	3 (5·7) [1·2, 15·7]	53
D						
8, 19, 37	1 (1·0) [0·0, 5·7]	2 (2·1) [0·3, 7·3]	1 (1·0) [0·0, 5·7]	89 (92·7) [85·6, 97·0]	3 (3·1) [0·7, 8·9]	96
9, 10	0	6 (5·2) [1·9, 11·0]	3 (2·6) [0·5, 7·4]	100 (87·0) [79·4, 92·5]	6 (5·2) [1·9, 11·0]	115
17, 23, 26, 27, 39, 44	0	0	0	4 (40·0) [12·2, 73·8]	6 (60·0) [26·2, 87·8]	10
E						
4	12 (4·3) [2·3, 7·5]	15 (5·4) [3·1, 8·8]	17 (6·1) [3·6, 9·6]	216 (78·0) [72·6, 82·7]	17 (6·1) [3·6, 9·6]	277
F						
40	73 (65·8) [56·2, 74·5]	25 (22·5) [15·1, 31·4]	1 (0·9) [0·0, 4·9]	1 (0·9) [0·0, 4·9]	11 (9·9) [5·1, 17·0]	111
41	199 (59·1) [53·6, 64·4]	90 (26·7) [22·1, 31·8]	6 (1·8) [0·7, 3·8]	3 (0·9) [0·2, 2·6]	39 (11·6) [8·4, 15·5]	337
Untyped subgenus F	114 (58·5) [51·2, 65·5]	60 (30·8) [24·4, 37·8]	5 (2·6) [0·8, 5·9]	0	16 (8·2) [4·8, 13·0]	195
N/K	65 (30·2) [24·2, 36·9]	34 (15·8) [11·2, 21·4]	12 (5·6) [2·9, 9·6]	58 (27·0) [21·2, 33·4]	46 (21·4) [16·1, 27·5]	215
Total	1121	910	186	804	292	3313

* Number of isolates (% of all isolates of the same serotype(s)) [95% confidence interval]. $\chi^2(60) = 1{,}945{\cdot}72$; $P < 0{\cdot}001$.

Subgenus D includes the epidemic conjunctivitis serotypes 8, 19 and 37 and small hospital based outbreaks of serotype 8 were recorded in 1991 and 1995. However, at least one isolation was made in every year of the period of study. Serotype 10 was rarely isolated except for the years 1990–3. The subgenus E serotype 4 was rare in 1983–5 but started to increase in 1986 and continued at a relatively high level until 1992. Declines in 1993 and 1994 were followed by an increase in 1995 that continued in 1996 where 26 isolations were made in the first 9 months of the year. Annual variation in incidence of subgenus F isolates was confined to small but significant reductions in 1990 and 1992.

Seasonal variation

A distinct difference in the monthly incidence between the closely related serotypes 3 and 7 from subgenus B was apparent (Table 2). Serotype 7 showed an

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Table 4. *Sex distribution of patients with adenoviruses isolated in Greater Manchester, UK, 1982–96*

Subgenus and species	Males	Females	N/K	Total
A				
12, 18, 31	9 (20·5) [9·8, 35·3]	22 (50·0) [34·6, 65·4]	13 (29·6) [16·8, 45·2]	44
B				
3	241 (52·3) [47·6, 56·9]	201 (43·6) [39·0, 48·3]	19 (4·1) [2·5, 6·4]	461
7	112 (49·1) [42·5, 55·8]	107 (46·9) [40·3, 53·6]	9 (4·0) [1·8, 7·4]	228
11, 14, 16, 21, 34/35	12 (46·2) [26·6, 66·6]	6 (23·1) [9·0, 43·7]	8 (30·8) [14·3, 51·8]	26
C				
1	227 (60·5) [55·4, 65·5]	145 (38·7) [33·7, 43·8]	3 (0·8) [0·2, 2·3]	375
2	311 (54·0) [49·8, 58·1]	243 (42·2) [38·1, 46·3]	22 (3·8) [2·4, 5·7]	576
5	104 (53·6) [46·3, 60·8]	79 (40·7) [33·7, 48·0]	11 (5·7) [2·9, 9·9]	194
6	26 (49·1) [35·1, 63·2]	25 (47·2) [33·3, 61·4]	2 (3·8) [0·5, 13·0]	53
D				
8, 19, 37	63 (65·6) [55·2, 75·0]	28 (29·2) [20·3, 39·3]	5 (5·2) [1·7, 11·7]	96
9, 10	69 (60·0) [50·5, 69·0]	43 (37·4) [28·6, 46·9]	3 (2·6) [0·5, 7·4]	115
17, 23, 26, 27, 39, 44	5 (50·0) [18·7, 81·3]	0	5 (50·0) [18·7, 81·3]	10
E				
4	131 (47·3) [41·3, 53·4]	136 (49·1) [43·1, 55·2]	10 (3·6) [1·7, 6·5]	277
F				
40	59 (53·2) [43·4, 62·7]	41 (36·9) [28·0, 46·6]	11 (9·9) [5·1, 17·0]	111
41	177 (52·5) [47·0, 58·0]	131 (38·9) [33·6, 44·3]	29 (8·6) [5·8, 12·1]	337
Untyped subgenus F	111 (56·9) [49·7, 64·0]	72 (36·9) [30·1, 44·1]	12 (6·2) [3·2, 10·5]	195
N/K	103 (47·9) [41·1, 54·8]	72 (33·5) [27·2, 40·2]	40 (18·6) [13·6, 24·5]	215
Total	1760	1351	202	3313

* Number of isolates (% of all isolates of the same serotype(s)) [95% confidence interval]. $\chi^2(30) = 236{\cdot}03$; $P < 0{\cdot}001$.

increased incidence in spring and summer (March–August) and a relatively low incidence in autumn and winter, whereas serotype 3 showed no evidence of seasonal variation. A similar disparity occurred with subgenus C where serotype 1 showed no seasonal variation, but there was a peak incidence in late winter and early spring (January–April) of serotype 2. With serotype 4 (subgenus E), incidence peaked in the summer (June–August) with a further peak, curiously, in December. There was a seasonal variation evident for subgenus F in that a significantly higher proportion of isolates occurred in autumn (September–November).

Age distribution

Overall, children younger than 5 years were the most common group of patients with adenovirus infections (Table 3). There were 2031/3313 (61·3%) isolates from this group compared to 804/3313 (24·2%)

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Table 5. *Clinical features of infants up to 4 years with adenovirus infections in Greater Manchester, UK, 1982–96*

Subgenus and species	Clinical symptoms							
	Eye	Respiratory	Gastric	General	Eye + respiratory	Eye + respiratory + gastric	Respiratory + gastric	Total
A								
12, 18, 31	0	1 (0·2) [−0·2, 0·6]	19 (2·1) [1·2, 3·0]	1 (0·4) [−0·4, 1·2]	0	1 (6·3) [−5·6, 18·1]	0	22
B								
3	14 (25·0) [13·7, 36·3]	74 (14·0) [11·0, 16·9]	27 (2·9) [1·9, 4·0]	24 (9·7) [6·0, 13·4]	7 (23·3) [8·2, 38·5]	4 (25·0) [3·8, 46·2]	11 (8·4) [3·6, 13·1]	161
7	12 (21·4) [10·7, 32·2]	39 (7·4) [5·1, 9·6]	17 (1·9) [1·0, 2·7]	18 (7·3) [4·0, 10·5]	13 (43·3) [25·6, 61·1]	5 (31·3) [8·5, 54·0]	15 (11·5) [6·0, 16·9]	119
11, 14, 16, 21, 34/35	0	1 (0·2) [−0·2, 0·6]	2 (0·2) [−0·1, 0·5]	0	0	0	0	3
C								
1	2 (3·6) [−1·3, 8·4]	128 (24·2) [20·5, 27·8]	62 (6·8) [5·1, 8·4]	63 (25·4) [20·0, 30·8]	3 (10·0) [−0·7, 20·7]	1 (6·3) [−5·6, 18·1]	34 (26·0) [18·4, 33·5]	293
2	2 (3·6) [−1·3, 8·4]	182 (34·3) [30·3, 38·4]	140 (15·3) [12·9, 17·6]	94 (37·9) [31·9, 43·9]	4 (13·3) [1·2, 25·5]	3 (18·8) [−0·4, 37·9]	30 (22·9) [15·7, 30·1]	455
5	3 (5·4) [−0·5, 11·3]	65 (12·3) [9·5, 15·1]	41 (4·5) [3·1, 5·8]	31 (12·5) [8·4, 16·6]	0	1 (6·3) [−5·6, 18·1]	12 (9·2) [4·2, 14·1]	153
6	0	19 (3·6) [2·0, 5·2]	9 (1·0) [0·3, 1·6]	5 (2·0) [0·3, 3·8]	1 (3·3) [−3·1, 9·8]	1 (6·3) [−5·6, 18·1]	2 (1·5) [−0·6, 3·6]	37
D								
8, 19, 37	3 (5·4) [0·0, 11·3]	0	0	0	0	0	0	3
9, 10	6 (10·7) [2·6, 18·8]	0	0	0	0	0	0	6
17, 23, 26, 27, 39, 44	0	0	0	0	0	0	0	0
E								
4	12 (21·4) [10·7, 32·2]	4 (0·8) [0·0, 1·5]	4 (0·4) [0·0, 0·9]	3 (1·2) [−0·2, 2·6]	2 (6·7) [−2·3, 15·6]	0	1 (0·8) [−0·7, 2·3]	26
F								
40, 41	0	1 (0·2) [−0·2, 0·6]	525 (57·3) [54·0, 60·5]	4 (1·6) [0·0, 3·2]	0	0	25 (19·1) [12·4, 25·8]	555
N/K	2 (3·6) [−1·3, 8·4]	16 (3·0) [1·6, 4·5]	71 (7·7) [6·0, 9·5]	5 (2·0) [0·3, 3·8]	0	0	1 (0·8) [−0·7, 2·3]	95
Total	56	530	917	248	30	16	131	1928

* Number of isolates (% of all isolates from patients with the same clinical symptoms) [95% confidence interval]. $\chi^2(78) = 1{,}448{\cdot}61$; $P < 0{\cdot}001$.

isolates from adults and only 186/3313 (5·6%) isolates from school age children, i.e. 5–15 years. A total of 292/3313 (8·8%) was from patients whose age had not been recorded. However, the different adenovirus subgroups showed statistically significant predilections for certain age groups. Subgenus A serotypes were isolated mainly from infants and pre-school children. From subgenus B, adenovirus types 3 and 7 were more commonly isolated from small children and adults but are the only serotypes where there were substantial numbers of isolates from all age groups. Also, adenovirus type 7 was more likely to be isolated from infants than small children. The other serotypes from subgenus B favoured school children and adults. Serotypes 2, 5 and 6 from subgenus C show a strong association with infants and small children with both these age groups equally likely to be affected. The exception is adenovirus type 1 which, although having the same strong association with these age groups, has a statistically significant higher predilection for infants over pre-school children. In the cases of subgenus D and E, there is an over-

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Table 6. *Clinical features of children between 5 and 15 years with adenovirus infections in Greater Manchester, UK, 1982–96*

Subgenus and species	Clinical symptoms							
	Eye	Respiratory	Gastric	General	Eye + respiratory	Eye + respiratory + gastric	Respiratory + gastric	Total
A								
12,18,31	0	1(2·8) [−2·6,8·1]	1(2·6) [−2·4,7·5]	0	0	0	0	2
B								
3	14(38·9) [23·0,54·8]	16(44·4) [28·2,60·7]	5(12·8) [2·3,23·3]	11(25·0) [12·2,37·8]	1	0	3	50
7	5(13·9) [2·6,25·2]	8(22·2) [8·6,35·8]	10(25·6) [11·9,39·3]	4(9·1) [0·6,17·6]	0	0	1	28
11,14,16,21, 34/35	0	0	2(5·1) [−1·8,12·1]	2(4·5) [−1·9,10·7]	0	0	0	4
C								
1	0	2(5·6) [−1·9,13·0]	0	8(18·2) [6·8,29·6]	0	0	1	11
2	3(8·3) [−0·7,17·4]	5(13·9) [2·6,25·2]	3(7·7) [−0·7,16·1]	9(20·5) [8·5,32·4]	0	0	1	21
5	0	1(2·8) [−2·6,8·1]	1(2·6) [−2·4,7·5]	2(4·5) [−1·9,10·7]	0	0	0	4
6	0	0	1(2·6) [−2·4,7·5]	3(6·8) [−0·7,14·3]	0	0	0	4
D								
8,19,37	1(2·8) [−2·6,8·1]	0	0	0	0	0	0	1
9,10	2(5·6) [−1·9,13·0]	0	0	1(2·3) [−2·5,6·7]	0	0	0	3
17,23,26,27, 39,44	0	0	0	0	0	0	0	0
E								
4	8(22·2) [8·6,35·8]	2(5·6) [−1·9,13·0]	4(10·3) [0·7,19·8]	2(4·5) [−1·9,10·7]	1	0	0	17
F								
40,41	0	0	9(23·1) [9·9,36·3]	0	0	0	2	11
N/K	3(8·3) [−0·7,17·4]	1(2·8) [−2·6,8·1]	3(7·7) [−0·7,16·1]	2(4·5) [−1·9,10·7]	0	0	0	9
Total	36	36	39	37	2	0	8	165

* Number of isolates (% of all isolates from patients with the same clinical symptoms) [95% confidence interval]. $\chi^2(78) = 101{\cdot}01$; $P < 0{\cdot}05$.

whelming association with adults. Subgenus F viruses were rarely found other than in infants and young children with a statistically significant predilection for the infants as compared to the pre-school children.

Sex distribution

Males were more likely to be infected with most adenovirus serotypes. The exceptions to this were those in subgenus A, where females were more susceptible, and adenovirus types 4, 6 and 7 where the frequency of infection was similar in both sexes (Table 4).

Clinical features (children less than 5 years)

The most common clinical syndrome in this age group was gastroenteritis with 917/1928 (47·6%) of isolates

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Table 7. *Clinical features of patients over 15 years with adenovirus infections in Greater Manchester, UK, 1982–96*

Subgenus and species	Clinical symptoms							
	Eye	Respiratory	Gastric	General	Eye + respiratory	Eye + respiratory + gastric	Respiratory + gastric	Total
A								
12, 18, 31	0	0	0	1	0	0	0	1
B								
3	177 (25·7) [22·4, 28·9]	2	1	4	3	0	0	187
7	46 (6·7) [4·8, 8·5]	3	3	4	4	0	2	62
11, 14, 16, 21, 34/35	4 (0·6) [0·0, 1·1]	2	0	2	1	0	0	9
C								
1	9 (1·3) [0·5, 2·2]	3	0	1	1	0	0	14
2	13 (1·9) [0·9, 2·9]	5	2	3	1	0	1	25
5	5 (0·7) [0·1, 1·4]	5	1	2	0	0	0	13
6	4 (0·6) [0·0, 1·1]	1	0	0	0	0	0	5
D								
8, 19, 37	85 (12·3) [9·9, 14·8]	0	1	0	0	0	0	86
9, 10	94 (13·6) [11·1, 16·2]	0	0	0	0	0	0	94
17, 23, 26, 27, 39, 44	0	0	3	0	0	0	0	3
E								
4	205 (29·7) [26·3, 33·1]	1	1	1	6	0	1	215
F								
40, 41	0	0	4	0	0	0	0	4
N/K	48 (7·0) [5·1, 8·9]	3	2	4	1	0	0	58
Total	690	25	18	22	17	0	4	776

* Number of isolates (% of all isolates from patients with the same clinical symptoms) [95% confidence interval]. $\chi^2(78) = 563{\cdot}27$; $P < 0{\cdot}001$.

followed by respiratory symptoms with 530/1928 (27·5%) and general symptoms with 248/1928 (12·9%) (Table 5). There were relatively few associated with conjunctivitis [56/1928 (2·9%)] and surprisingly few with a combination of symptoms, e.g. pharyngoconjunctival fever [30/1928 (1·6%)], although respiratory together with gastric symptoms were more common [131/1928 (6·8%)]. Subgenus F serotypes were present in 57·3% of cases with gastric symptoms and were almost exclusively [550/555 (99·1%)] isolated from such cases. The overall numbers of subgenus A serotypes was small but 20/22 (90·9%) of isolates were also from patients with gastric symptoms. Serotypes from subgenus C were most commonly found with respiratory or general symptoms. Statistically significantly fewer, but still a large number, were also found with gastric symptoms and this occurred with similar frequencies for serotypes 1 and 5 but a statistically significant higher frequency with serotype 2. Very few isolates of subgenus C were from patients with conjunctivitis. A different picture emerged with subgenus B where both

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Table 8. *Records of adenovirus from different sites from patients in Greater Manchester, UK, 1982–96*

Subgenus and serotype	Faecal	Eye swab	Throat swab	NPA	Urine
A					
12,18,31	39	0	3	0	2
B					
3	54	247	131	19	3
7	56	70	76	17	3
11,14,16,21,34/35	8	7	2	1	6
C					
1	133	15	158	57	9
2	236	20	226	69	13
5	80	8	86	11	5
6	21	5	17	7	0
D					
8,19,37	1	92	0	0	0
9,10	0	114	1	0	0
17,23,26,27,39,44	10	0	0	0	0
E					
4	14	248	11	3	0
F					
40	111	0	0	0	0
41	336	0	0	0	0
Untyped subgenus F	192	0	1	0	0
All subgenus F	639	0	1	0	0
Not known	124	61	6	8	0
Total	1415	887	718	192	41

serotypes 3 and 7 were isolated from 25·0% and 21·4% of conjunctivitis cases respectively. However, the largest number of isolates of these serotypes was from respiratory cases followed by those with gastric or general symptoms. Very few isolates from subgenus D (9) and subgenus E (26) were made from this age group, but both were more likely to be found with eye symptoms than any other syndrome.

Clinical features (children 5–15 years)

Very few isolations of adenoviruses were made from this age group and thus in Table 6, the numbers for the different clinical syndromes are small. There were similar numbers of isolates from clinical categories of conjunctivitis (36), respiratory (36), gastrointestinal (39) and general symptoms (37) which together accounted for 148/165 (89·7%) of the total in this age group. The serotypes found in these four syndromes were serotypes 3, 7, 2 and 4 with, as expected, subgenus F serotypes appearing in the gastric cases only. Within subgenus B, serotype 3 was more commonly found with conjunctivitis, respiratory or general symptoms than serotype 7 whereas this position was reversed with the gastric cases.

Clinical features (adults over 15 years)

The overwhelming majority [690/776 (88·9%)] of isolates in this group of patients were from cases of conjunctivitis (Table 7). Of these, serotype 4 was the most common with 205/690 (29·7%) closely followed by serotype 3 with 177/690 (25·7%). Also within subgenus B, there were 46/690 (6·7%) isolations of serotype 7. In subgenus D, there were 85 isolates of serotypes 8, 19 or 37 with 8 the most common (67) and 94 isolates of serotypes 9 or 10, most of which were 10 (90). Relatively few isolates were from subgenus C with a total of 31/690 (4·5%) and none from subgenus A or F. Very few isolates from other clinical categories were made and in total amounted to only 86/776 (11·1%).

Occurrence in different specimen sites

Members of subgenera A and F were overwhelmingly isolated from faecal specimens whereas serotype 4

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(subgenus E) isolations were nearly all from eye swabs (Table 8). In the case of subgenera B and C, isolations were made from all specimen types although there was a preponderance of serotype 3 from eye swabs but relatively few of subgenus C came from eye swabs. Interestingly, almost all serotypes 8–10, 19 and 37 were from eye swabs, whereas the remaining serotypes from subgenus D, although few in number, came exclusively from faecal specimens. Few isolations were made from urine, but of these, the largest proportion (6/24) was from subgenus B other than serotypes 3 and 7. All six were serotype 11.

DISCUSSION

Presented here is a data analysis of more than 3000 records of adenovirus isolation in Manchester from October 1982 to September 1996. All isolations, therefore, were made only from those whose illness warranted the taking of diagnostic specimens. In terms of age distribution, the most striking finding was the very small numbers of cases involving school-age children (5–15 years). This may suggest that they have already been exposed to the common endemic serotypes of subgenera C and F early in life and have thereby established a protective immunity. However, seroepidemiological studies will be required to support this hypothesis. Another possibility is that the respiratory or gastric symptoms in this age group were not severe enough to warrant further investigation. In this context, it is noteworthy that infections in adulthood were almost entirely due to conjunctivitis, a condition more likely to lead to a visit to a specialist ophthalmic clinic or emergency eye treatment centre.

Overall, there was a significantly higher proportion of males with adenovirus infection, a phenomenon also reported previously [6]. However, in this study, subgenus A was significantly more common in females despite the relatively large number of cases where the sex was not recorded. Also, in contrast to [6], subgenus D was more common in males and serotype 4 (subgenus E) was found in both sexes with equal frequency.

The epidemic character of serotypes 4, 7, 8 and 10 were confirmed in this study. However, with the common subgenus B isolate, serotype 3, this epidemic nature was much less obvious and in most years (10/13) significant numbers of isolations were made. The endemic nature of subgenus C is clearly shown with serotypes 1 and 2 but was less obvious with serotype 5 where there were several years when few isolations were made. Similar observations have been made by others [6]. When serotypes 40 and 41 were counted together as subgenus F, their endemic nature was clearly shown. It is difficult to draw conclusions about the individual serotypes because in most years significant numbers were untyped.

A few serotypes showed evidence of seasonal variation. In subgenus C, serotype 2 was more prevalent in winter and early spring, consistent with earlier data [5, 6] but this was not apparent with serotype 1. There was no obvious seasonal variation with serotype 3 in contrast to serotype 7 which showed a peak incidence in spring and early summer, earlier to previous reports which suggested a peak in late summer [6, 20]. Subgenus F was more prevalent in Autumn (September–November), an observation which agrees with work in Japan [21] but differs from previous work in Manchester [16] perhaps because of the shorter period (5 years) of the latter study. Serotype 4 was the only other adenovirus to show a seasonal variation with a peak in the summer months. As most of these isolates were from conjunctivitis cases, this is consistent with Shinozaki and colleagues [22] who found adenoviral conjunctivitis in Japan to be most prevalent in July and August.

The clinical occurrence of some adenoviruses was clear-cut. Thus, subgenera A and F were exclusively found with gastroenteritis in infants and subgenera D and E were rarely found other than in conjunctivitis cases of adults. Subgenus C was mainly found in young children with respiratory or general symptoms but significant numbers had gastric symptoms. They were rarely found in eyes in any group of patients. Subgenus B showed a similar range with the exception that in young children and adults they were a significant cause of conjunctivitis. Despite adenoviruses being traditionally associated with pharyngo-conjunctival fever, there were surprisingly few patients reported to have this condition. We do not know if this is genuinely uncommon in Manchester, whether it is a reflection of incomplete descriptions of symptoms on request forms by busy clinicians or whether these patients were not referred to hospital. There is little doubt that the numbers of adenovirus associated with conjunctivitis is underrepresented. The local eye hospital does not routinely collect swabs from patients with what is regarded, on clinical grounds, as typical adenovirus conjunctivitis. Thus, the eye swabs received were only from severe and/or atypical cases. Not only does this affect the overall numbers, but it may also

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bias the range of serotypes found if those underrepresented here are more likely to cause typical and/or mild symptoms. However, previous ocular studies in other countries have also found the same predominance of serotypes 3, 4, 7 and subgenus D [23, 22]. New rapid and sensitive techniques may, in the future, give more information on the true prevalence of adenoviruses in conjunctivitis [24].

The clinical occurrences were closely mirrored by the incidence of adenovirus in different specimen sites. Subgenera A and F came almost exclusively from faecal specimens, subgenera D and E from eye swabs and subgenera B and C from a variety of sites reflecting their association with a wider range of symptoms. Over the 14-year period, relatively few adenoviruses were isolated from urine.

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