Severe and unrecognised: pertussis in UK infants

N S Crowcroft, R Booy, T Harrison, L Spicer, J Britto, Q Mok, P Heath, I Murdoch, M Zambon, R George, E Miller

Aims: To diagnose pertussis using culture, polymerase chain reaction, and serology, in children admitted to intensive care units (PICUs) and some paediatric wards in London, and in their household contacts to determine the source of infection.

Methods: Infants <5 months old admitted to London PICUs between 1998 and 2000 with respiratory failure, apnoea and/or bradycardia, or acute life threatening episodes (ALTE), and children <1 year admitted to paediatric wards at St Mary’s and St George’s Hospitals between 1999 and 2000 with lower respiratory tract infection, apnoea, or ALTE were studied.

Results: Sixty seven per cent of eligible children (142/212) were recruited; 23% (33/142) had pertussis, 19.8% (25/126) on the PICU and 50% (8/16) on wards. Two died. Only 4% (6/142) were culture positive. Pertussis was clinically suspected on admission in 28% of infants (7/25) on the PICU and 75% (6/8) on the wards. Infants on PICU with pertussis coughed for longer, had apnoeas and whooped more often, and a higher lymphocyte count than infants without pertussis. Pertussis and respiratory syncytial virus (RSV) co-infection was frequent (11/33, 33%). Pertussis was confirmed in 22/33 (67%) of those who were first to become ill in the family. For 14/33 children the source of infection was a parent; for 9/33 the source of pertussis was an older fully vaccinated child in the household.

Conclusions: Severe pertussis is under diagnosed. An RSV diagnosis does not exclude pertussis. Future changes to the UK vaccination programme should aim to reduce pertussis transmission to young infants by their parents and older siblings.
Pertussis in UK infants

Table 1  Laboratory results for children with microbiologically confirmed pertussis (excludes nine epidemiologically linked cases)

<table>
<thead>
<tr>
<th>PCR</th>
<th>Culture positive</th>
<th>Culture negative</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Serology positive</td>
<td>Serology not received</td>
<td>Serology positive</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Not received</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>PICU</td>
<td>Positive</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Not received</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Ward</td>
<td>Total</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

*Specimen results would not meet the diagnostic criteria for a case of pertussis and so would not appear in this table.

Research nurses obtained nasopharyngeal aspirate, and acute and convalescent sera from eligible infants on PICU. From the generally older eligible children on the wards, they took pernasal swabs. Pernasal swabs were taken from adult and child household contacts and a single blood specimen from adult contacts only. For mothers only, we obtained stored antenatal serum where available.

A case of pertussis infection was diagnosed if one or more of the following was found:

- **Bordetella pertussis** isolated by culture
- Polymerase chain reaction (PCR) positive for two targets—
  - the pertussis toxin gene (ptxA) and insertion element IS481 sequences
- PCR positive with one target in duplicate samples
- Pertussis toxin (PT) IgG antibody levels greater than 100 U/ml.

If a child did not meet these criteria but one or more of their household contacts had been ill and met the diagnostic criteria for confirmed pertussis, the child was designated an epidemiologically linked case. Infants with pertussis were compared in the analysis with other recruited infants who did not meet the study diagnostic criteria for pertussis.

Household members were regarded as having a confirmed infection with *B pertussis* if they met the criteria above for a case or, in the absence of a clinical specimen, they had an illness compatible with pertussis and were epidemiologically linked to another confirmed case in the family.

The source of infection was defined by the individual in the household with the earliest date of onset of cough (or of admission for two infants with no cough). If household members became ill with dates of onset separated by five days or less, they were considered to be co-primary cases.

For the first year, samples were transported to the laboratory within four hours of collection and processed within one hour of delivery. Culture of these samples was carried out by standard PHLS methods. In the subsequent year, samples were frozen rapidly to −70°C and transported frozen. Pertussis PCR was carried out using single round PCRs to minimise contamination risk, with two independent targets providing mutual confirmation and a range of controls. The ptxA PCR targets the pertussis toxin promoter region yielding a 191bp product and has a reported sensitivity of six bacteria per reaction. The IS481 PCR targets the *B pertussis* insertion sequence IS481, yielding a 146bp product, and has a reported sensitivity of three bacteria per reaction. Control measures included: for sensitivity, titration of a positive control within each run; for specificity, a dummy sample (phosphate buffered saline in place of the clinical sample) per run, and 2–3 water blanks per run. Serology for pertussis toxin (PT) IgG antibody using PT antibody as a marker of recent infection with pertussis was undertaken as previously described. Use of paired and single high titre diagnostic criteria have been evaluated in the European Sero-epidemiology Network (ESSEN) project and elsewhere. RSV and influenza detection were carried out by multiplex nested PCR. RSV positive results from nasopharyngeal aspirate which had been taken more than 48 hours after admission were excluded as potentially nosocomial infections. Clinicians were aware that the study was ongoing but laboratory results were not made available in real time.

For the data analysis, groups were compared for categorical variables using χ² tests, and for continuous variables by *t* test or by Mann-Whitney test for non-parametric data.

RESULTS

We recruited 126/183 eligible infants (69%) admitted to the PICUs and 16/29 children (55%) admitted to wards. Nurses obtained 79% specimens within two days of admission, with a median time of one day between admission and sampling. The mean duration of illness prior to taking specimens was 13 days for the ward cases and 18 days for PICU cases (p = 0.4). For the household contacts, questionnaire data were available for 128/300 adults (94%) and 186/192 other children in the household (97%). Specimens were obtained from 81% adult and 43% child contacts.

Pertussis PCR was positive in 18/138 (13%) specimens received from recruited children, 16/235 (7%) pernasal swabs from their adult contacts, and 4/85 (5%) pernasal swabs from child contacts. Pertussis was diagnosed according to the case definition in 25/126 (19.8%, 95% confidence interval (CI) 12.9% to 26.8%) infants on PICU and 8/16 (50%, 95% CI 24.7% to 75.3%) children on the wards. Of the 25 cases on the PICU, 17 were laboratory confirmed and eight were epidemiologically linked cases (table 1). Five infants with confirmed pertussis on PICU were diagnosed by pertussis PCR alone, and two were diagnosed on the basis of serology only (table 1). Specimens from 2/126 (2%) PICU infants and one ward infant were culture positive. Of the ward cases, 7/8 were confirmed and one was epidemiologically linked. Of the total of nine epidemiologically linked infants on the PICU and wards, three had equivocal PCR results and negative serology, and six were negative by PCR but no serum was obtained. Pertussis was suspected on admission in 7/25 (28%) infants who met the study criteria on the PICU and 6/8 (75%) infants on the wards. There was a tendency for the ward cases to have more “typical” features (table 2).

Antibiotics had been given prior to admission to seven children with pertussis and 15 with another diagnosis. This had included a macrolide antibiotic in one child with confirmed pertussis and three with other diagnoses. A further five children had specimens taken for the study after starting
in-patient antibiotics. Pertussis was confirmed in none of these children. Four of these five infants received a macrolide antibiotic for one to seven days before the specimens were obtained. All infants with pertussis received antibiotics during the PICU admission, but for 7/25 this did not include a macrolide antibiotic.

Infants admitted to the PICU with pertussis were not more likely to cough than infants with other diagnoses (table 2). However, they were significantly more likely to have had apnoeas (p = 0.03), and to whoop (p < 0.005). Of infants with an admission diagnosis of apnoea alone, 3/10 (33%) had pertussis. Two infants died, both previously well infants born at full term, compared with six deaths of infants without pertussis. The duration of ventilation, stay on the PICU, and total hospital admission of the 25 infants with pertussis were not significantly different to those with other diagnoses, but they had longer durations of cough and higher lymphocyte counts (table 3). The ward children had a median duration of cough of 12 days (interquartile range (IQR) 7 to 19.3), median lymphocyte count of 15.6 × 10^9/l (IQR 2.3 to 7.8), and median length of stay of 7.0 days (IQR 10.5 to 23.5). Similarly to the PICU infants, the ward children with pertussis had a longer median duration of cough (p = 0.03), and higher lymphocyte count (p = 0.004) than children with other diagnoses, but their overall length of admission was not significantly different (p = 0.9).

Most PICU infants with pertussis were unvaccinated because they were too young: 16/25 were less than 2 months old. PICU infants with pertussis were as likely to have received fewer than the recommended number of doses of pertussis vaccine than those without pertussis (5/25 (20%) compared with 33/101 (32.7%); p = 0.2). Ward babies were “under vaccinated”, with 5/8 (71.4%) with pertussis having received fewer than recommended for their age versus 1/8 vaccinated”, with 5/8 (71.4%) with pertussis having received 33/101 (32.7%); p = 0.2). Ward babies were “under vaccinated”, with 5/8 (71.4%) with pertussis having received fewer than the recommended number of doses of pertussis vaccine than those without pertussis (5/25 (20%) compared with 33/101 (32.7%); p = 0.2). Ward babies were “under vaccinated”, with 5/8 (71.4%) with pertussis having received fewer than recommended for their age versus 1/8 (12.5%) without pertussis (p = 0.1).

In total, 26/289 contacts of recruited PICU infants and 6/39 children recruited on the wards had laboratory confirmed pertussis. The families of a baby with pertussis had a median number of laboratory confirmed cases (in addition to the hospitalised child) of one, with a range of 0–2 cases. Sixty of 111 (54%) contacts of children with confirmed pertussis had a cough versus 144/351 (41%) contacts of children admitted with other diagnoses (p = 0.02). Duration of cough was available for 168/204 coughing contacts. The median duration of cough in contacts of pertussis cases was 13.5 days compared with 7.5 days in other contacts (p = 0.04). A clinical case definition of 21 or more days coughing plus at least one of paroxysms, whooping, or vomiting was met by 10/111 (9%) contacts of pertussis cases compared with 9/351 (3%) other contacts (p = 0.006). Pertussis was confirmed in 6/17 (35%) contacts who met this case definition compared with 26/311 (8%) who did not (p = 0.003).

Primary cases (the source of infection) included parents and other children in the households (table 4); 67% of primary cases were laboratory confirmed. The greatest level of non-confirmation occurred when a child was the primary case, largely because we obtained fewer specimens from children. Of seven unconfirmed primary cases in child contacts, no specimens were obtained for four. Two of the three unconfirmed cases with a negative pertussis PCR result met a clinical case definition of coughing for 21 days or more, and coughed for 30 and 60 days respectively. Seven PCR positive contacts and a three contacts with serological evidence of recent infection were asymptomatic prior to and at the time of sampling and did not develop symptoms in the 6–8 weeks before follow up of the infant.

All siblings who were a possible source of infection were reported to be fully vaccinated. In total, 91% of adult contacts (30/33) and 97% of child contacts (29/31) of PICU infants with microbiologically confirmed pertussis reported having been vaccinated for pertussis in the past. This was not significantly lower than reported for contacts of PICU infants without pertussis (adults: 94%, 133/141; children: 95%, 120/127).

RSV co-infection occurred in nine PICU infants with pertussis and two ward children. Infants on PICU with

### Table 2 Clinical features of children on PICU and wards with pertussis (including linked cases) compared with children on PICU with other diagnoses (categorical variables)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ward: pertussis (n=25)</th>
<th>PICU: pertussis (n=101)</th>
<th>PICU: other diagnoses (n=101)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cough</td>
<td>8/8</td>
<td>23/25</td>
<td>82/101</td>
</tr>
<tr>
<td>Paroxysmal</td>
<td>6/8</td>
<td>14/24</td>
<td>34/89</td>
</tr>
<tr>
<td>Whoop</td>
<td>4/4</td>
<td>9/24</td>
<td>3/87</td>
</tr>
<tr>
<td>Vomiting</td>
<td>4/4</td>
<td>15/25</td>
<td>49/101</td>
</tr>
<tr>
<td>Fever</td>
<td>5/8</td>
<td>11/25</td>
<td>45/101</td>
</tr>
<tr>
<td>Apnoea</td>
<td>3/8</td>
<td>17/25</td>
<td>40/100</td>
</tr>
<tr>
<td>Cyanosis</td>
<td>8/8</td>
<td>16/25</td>
<td>51/100</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>0</td>
<td>5/25</td>
<td>14/96</td>
</tr>
<tr>
<td>Conjunctival haemorrhage</td>
<td>0</td>
<td>1/25</td>
<td>3/101</td>
</tr>
<tr>
<td>Death</td>
<td>0</td>
<td>2/25</td>
<td>6/101</td>
</tr>
</tbody>
</table>

### Table 3 Clinical features of children on PICU with pertussis (including linked cases) compared with children on PICU with other diagnoses; continuous variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>PICU: pertussis (n=25)</th>
<th>PICU: other diagnoses (n=101)</th>
<th>Mann-Whitney test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of cough (days)</td>
<td>15.2</td>
<td>8.5</td>
<td>11.0</td>
</tr>
<tr>
<td>Lymphocyte count (× 10^9/l)</td>
<td>8.8</td>
<td>7.8</td>
<td>4.5</td>
</tr>
<tr>
<td>Duration of ventilation (days)</td>
<td>4.6</td>
<td>3.5</td>
<td>4.8</td>
</tr>
<tr>
<td>Length of stay on PICU (days)</td>
<td>5.7</td>
<td>4.5</td>
<td>8.2</td>
</tr>
<tr>
<td>Length of total hospital admission (days)</td>
<td>15.6</td>
<td>13.0</td>
<td>15.2</td>
</tr>
</tbody>
</table>
co-infection did not have more severe illness than those with other diagnoses, with no statistically significant difference in duration of ventilation, admission to PICU, or total hospital admission.

**DISCUSSION**

Pertussis is a more frequent cause of admission to PICU than generally recognised. Although the numbers in this study are small, for most of the infants the presentation was not typical, the diagnosis was unsuspected, and the case would not have been investigated or notified as pertussis. The combination of pertussis PCR and serology greatly enhanced diagnostic sensitivity in young hospitalised infants, with implications for surveillance and infection control. Hospitalised infants with pertussis including fatal cases are under notified.1 12 This study shows that, in addition to under notification, under ascertainment is occurring of severely affected infants requiring admission to a PICU. The true number of severe infections, particularly fatal cases, is extremely important in determining the likely benefits of booster vaccinations in modelling different policy options.13 On the basis of this study, the Health Protection Agency now offers PCR and serology to improve diagnosis of pertussis for such infants, and the results are contributing to enhanced surveillance.1

Twenty eight per cent of infants with proven pertussis did not receive a macrolide antibiotic and risked transmitting the infection to staff and other patients. Pertussis is extremely infectious, and a missed diagnosis in PICU may lead to outbreaks among extremely vulnerable infants.

Infants with pertussis were not more ill than those with other diagnoses causing similar clinical syndromes. Co-infection with RSV occurred frequently but did not adversely affect outcome. Samples were collected too close to the point of admission for these co-infections to be nosocomial. Co-infection with pertussis and RSV has been described previously to cause severe infections.14 15 The different findings in this study may be a chance result because the number of co-infections was small. Alternatively it may reflect greater sensitivity of diagnostic methods for both pertussis and RSV, which means that either or both may be detected outside the window of acute infection. In addition, either agent may influence the transmissibility of the other without influencing disease severity. It is important to recognise co-infections, both for infection control and clinical management. A diagnosis of RSV does not exclude pertussis, and vice versa.

Ten contacts had no symptoms, but *B pertussis* DNA was detected by PCR of nasopharyngeal swabs, or PT IgG levels indicated recent infection. There are several possible explanations, including false positive results, “carriage” of *B pertussis*, modification of disease through vaccination, subclinical infection with immunological boosting, and incubating disease. While false positive results are always a risk of PCR, we applied stringent methods and we believe that the diagnostic criteria errored on the side of risking false negative results rather than false positive ones. Although *B pertussis* carriage has not been recognised previously,16 we may need to change our perspective in the light of the results of highly sensitive diagnostic methods. If carriage does occur, this might explain persist-
Authors’ affiliations
N S Crowcroft, L Spicer, E Miller, Immunisation Division, HPA Communicable Disease Surveillance Centre, 61 Colindale Avenue, London NW9 5EQ
R Booy, J Britto, Imperial School of Medicine at St Mary’s Hospital, Praed Street, London W2 1NY
Q Mok, Great Ormond Street Hospital for Children NHS Trust, Great Ormond Street, London WC1N 3JH
T Harrison, R George, HPA Respiratory and Systemic Infection Laboratory, HPA Central Public Health Laboratory, 61 Colindale Avenue, London NW9 5HT
P Heath, Department of Child Health, St George’s Hospital Medical School, Cranmer Terrace, London SW17 0RE
I Murdoch, Guy’s, King’s and St Thomas’s Medical School, Paediatric Intensive Care Unit, Guy’s Hospital, St Thomas’s Street, London SE1 9RT
M Zambon, HPA Respiratory Virus Unit, HPA Central Public Health Laboratory, 61 Colindale Avenue, London NW9 5HT

REFERENCES
Severe and unrecognised: pertussis in UK infants

N S Crowcroft, R Booy, T Harrison, L Spicer, J Britto, Q Mok, P Heath, I Murdoch, M Zambon, R George and E Miller

Arch Dis Child 2003 88: 802-806
doi: 10.1136/adc.88.9.802
eyesight in peril” are two of the section headings. The symptoms of attention deficit disorder can be explained almost entirely by excessive or inappropriate use of television and computers, in Large’s opinion.

The suggestion that we are being manipulated by advertisers and large television companies, whose main goal is, of course, that the TV is on for a longer rather than a shorter time, is thought provoking. Large proposes that television is, by its very nature, addictive. Advertising directed at children is not illegal in this country, although children younger than 8 are developmentally unable to understand the aims of advertising, simply accepting all claims as true. Children’s programmes, such as Teletubbies, are marketed as educational when there is no evidence to support the suggestion that they have any beneficial effect on development.

The final section of the book offers parents some practical advice on controlling and monitoring their children’s TV and internet use. Large suggests that children younger than 7 should watch no TV, benefitting much more from creative play and adult interaction.

Awareness of the impact of the media on children is steadily increasing. Set free childhood presents an extreme view of the possible negative consequences of our current viewing habits. The issue is not as clear cut as Large suggests, but it is time that we take greater interest in the media habits of the children we see, and consider the ways this may be influencing their health or development. A media history may be as necessary a part of any developmental history as a medical history may be to one in the medical history will cause the general practitioner to trip up frequently, serving to remind us all that there are frequent pitfalls in the practice of medicine. Despite this I would urge readers not to be deterred and continue past the first 14 pages of this book. This is in relation to the claim of the publishers that the book has been more than adequately reviewed and that the book is a comprehensive and comprehensive guide to the treatment of epilepsy. This book is a comprehensive and comprehensive guide to the treatment of epilepsy.

How large is your desk space? How many of us have placed a dozen new shiny books on our desk just hoping that the information will seep by osmosis into our brains while we snooze and drool over our revision? The MRCPCH examination is a battle but to buy a small (expensive) library of textbooks?

This new textbook, the publishers claim, will provide “all the information that the senior house officer and specialist registrar in paediatrics will need during their training and when preparing for the MRCPCH examination”. Quite a claim to make, especially when the editors themselves acknowledge that there will be inevitable gaps in a book of this size. So is this claim justified?

This textbook approaches paediatrics in a structured and comprehensive manner, modelled on the “core knowledge” and “particular problems” style suggested by the RCPCH publication, A syllabus and training record for general professional training in paediatrics and child health (1999). The list of contributors is striking (each acknowledged specialists in their field): 34 in total, including 2 professors and 24 consultants (like reading the dedication page of a textbook, the numbers are important when one is revising). The book covers the expected major systems but also includes chapters on community child health, development and learning difficulties, clinical genetics, injuries and ingestion, ophthalmology, surgery, and tropical paediatric medicine.

Each chapter is divided into three elements: firstly covering the background science and relevant investigations critical to diagnosis, secondly the core system problem, and finally a bibliography incorporating suggestions for further reading and key primary papers and review articles. The background science section is excellent. It includes up-to-date material on embriology, anatomy, biology, and physiology, which really does negate the need to search out those old medical student textbooks to jog one’s memory of basic sciences. Included in this section lies succinct summaries of appropriate investigations and their relevance. The core system problems are approached in a systematic and thorough way covering causes, classifications, differentials, clinical features, investigations, management and outcomes. Of particular attraction is the use of short case history boxes, key learning points, flow diagrams, tables, and photographs.

The editors have certainly been brave in trying not only to produce a textbook to cover the recommended RCPCH syllabus but also to help trainees achieve the required standards set out in A framework of competencies for basic specialist training in paediatrics (2004). Their caveat of the “inevitable gaps” has been more than adequately addressed by the encompassing further reading section that includes pertinent and up-to-date book references, reviews, and most importantly, useful websites.

Although this book is primarily aimed at trainees in the lead up to examinations, it is sure to be of value to those specialist registrars beyond this stage. The claim of relevance to all candidates preparing for the examination worldwide certainly does hold true, however some may be confused by the entirety of references to and from the Scottish Executive document of 2004 in the first chapter. This is in relation to Health for all children and child surveillance and is obviously due to the striking contributor list being almost exclusively Scottish in origin. Despite this I would urge users not to be deterred and continue past the first 14 pages to where the Children Act is discussed in
terms of both the English and Welsh Act of 1989 and the Scottish Act of 1995. The rest of the book undoubtedly has worldwide relevance, especially with the chapter on parasitic infections, malaria, and malnutrition.

This text provides the trainee with a valuable reference source that certainly reinforces the suggestion that learning should be integrated. As to the claim of providing all the information a trainee could need, the authors and editors are to be congratulated on producing concrete foundations for paediatric education and learning. You may only need limited desk space after all, just enough room for this book.

G Modgil

Towards MRCPCH Part II theory examination

Edited by Tapabrata Chatterjee. Hodder Arnold, 2005, £12.99 (US$23 (approx); €20 (approx)), pp 103. ISBN 0340905840

“How many?” I asked. “Oh, at least 3000 multiple-choice questions” said the experienced exam-positive senior registrar. That was the number of multiple-choice questions I should complete to achieve a successful result in my Part I MRCPCH. I never found out whether that meant actual questions or individual stems. Nevertheless, I completed well over this number during revision and did indeed pass. Whether my success had been related to question number or not, I sought to find just how many data interpretation and grey cases one must do in order to pass the next formidable hurdle.

The answer appeared to lie not in quantity but recognising patterns of questioning and developing the art of identifying pertinent information and clues within the questions. The topics chosen by Dr Chatterjee are representative of those that have been asked in the exam over the last five years. Although obviously dependent on candidate recall, the 75 data interpretation questions do appear to be typical of those in the examination. They include the obvious differential diagnoses, family tree and audiograms. There is the standard explanation section, which provides crisp answers with few comments.

The grey case section is superior with a good variety of thoughts to the expected complex paediatric cases as well as those still in training. These remain in strong agreement with the comments in the foreword that this book will remain an invaluable reference for those that have already attained the MRCPCH examination as well as those still in training. These pictures are certainly worth far more than ten thousand words.

G Modgil

CORRECTION


In the process of carrying out further analysis of the data from this study and to examine the role of respiratory syncytial virus (RSV) the author uncovered a single data entry error in the date of onset of disease in one contact of a case when looking back at the original questionnaires. Unfortunately this changes the order of cases in one family, which affects table 4 (the corrected table 4 is shown below).

The penultimate and last sentences of the Results section of the Abstract should have read:

Pertussis was confirmed in 21/33 (64%) of those who were first to become ill in the family. For 13/33 children the source of infection was a parent; for 10/33 the source of pertussis was an older fully vaccinated child in the household.

In the third to last paragraph of the Results section the first sentence should read:

Primary cases (the source of infection) included parents and other children in the household (table 4); 64% of primary cases were laboratory confirmed.

The error has no implications for the methods, discussion or conclusions of the paper.

Table 4: Proportion of laboratory confirmed cases amongst primary (first) cases in families of pertussis cases in PICU and wards

<table>
<thead>
<tr>
<th>Relationship</th>
<th>PICU</th>
<th>Ward</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent</td>
<td>9/10</td>
<td>2/3</td>
<td>11/13</td>
</tr>
<tr>
<td>Sibling</td>
<td>0/7</td>
<td>2/3</td>
<td>2/10</td>
</tr>
<tr>
<td>Baby or co-primary</td>
<td>6/8</td>
<td>2/2</td>
<td>8/10</td>
</tr>
<tr>
<td>Total</td>
<td>15/25</td>
<td>6/8</td>
<td>21/33</td>
</tr>
</tbody>
</table>

Pre-published book reviews

Book reviews that have been accepted for publication but have not yet been published in the print journal can be viewed online at http://adc.bmjjournals.com/misc/bookreviews.shtml

www.archdischild.com