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Infectious diseases in children admitted from a residential child care centre

留宿幼兒中心兒童的傳染病

Objectives. To describe the pattern of infectious diseases among children admitted from a residential child care centre and to identify any unusual clusters of admissions.
Design. Retrospective case review.
Setting. Regional hospital, Hong Kong.
Patients. All children from a residential child care centre aged over 28 days who were admitted from the Accident and Emergency Department to paediatric wards for infections from 1 January 1999 to 31 December 2003.
Main outcome measures. Demographic data, clinical diagnoses, infectious diseases identified, and incidence and seasonal pattern of various infections.
Results. Of 267 children admitted to the hospital over the 5-year period, 221 had infectious diseases. Respiratory tract infections, viral exanthema, and gastroenteritis were present in 83.7%, 7.2%, and 5.9%, respectively. Among those with a respiratory tract infection, 22.7%, 9.2%, and 8.6% had respiratory syncytial virus, parainfluenza virus, and influenza A or B viruses, respectively. Two unusual clusters of respiratory syncytial virus and parainfluenza virus were recognised in late 2003.
Conclusion. Children in this residential child care centre were at risk of infectious diseases. Respiratory tract infection is the most common infectious disease in this centre. An outbreak of respiratory tract infection was recognised. Further efforts may be necessary to improve infection control measures in this setting.

目的：描述醫院從留宿幼兒中心接收的兒童感染傳染病的模式，以及辨識入院患者中是否出現不尋常的集體病毒感染。
設計：病例回顧研究。
安排：分區醫院，香港。
患者：1999 年 1 月 1 日至 2003 年 12 月 31 日期間，急症室從一所留宿幼兒中心接收後轉介兒科病房、年齡在 28 天以上受感染的兒童。
主要結果測量：與人口調查有關的數據、臨床診斷、確定患上的傳染病類別、各種傳染病的發病率和季節性模式。
結果：5年內共接收267位病童，其中221名患上傳染病，包括呼吸道感染(83.7%)、病毒性泡疹(7.2%)和胃腸炎(5.9%)。呼吸道感染包括呼吸道合胞病毒(22.7%)、副流感病毒（9.2%）、甲型或乙型流行性感冒病毒（8.6%）感染。2003 年末分別發現呼吸道合胞病毒和副流感病毒不尋常集體感染的個案。
結論：該留宿幼兒中心的兒童較易患上傳染病。中心曾經爆發呼吸道感染一次，而呼吸道感染也是中心最易出現的傳染病，須加強防疫措施。

Key words:
Child care;
Disease outbreaks;
Infection control;
Respiratory syncytial virus infections

關鍵詞：
幼兒護理；
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傳染病控制；
呼吸道合胞病毒感染

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Introduction

Infectious diseases are an important cause of mortality and morbidity in children and are of particular concern in child care centres. An environment in which many children live closely together favours the acquisition and transmission of various types of infective organisms. The frequency of infections in these children is higher and the severity is also greater. Outbreaks of infection have a significant social and economic impact.[1] Outbreaks of food poisoning and gastroenteritis in child day-care centres have been described in local as well as overseas literature.[2-5] Outbreaks of other infectious diseases in residential child care centres have been less commonly reported. Epidemiological surveillance

plays an important role in infection control and provides information on the incidence of certain infections and their pattern of occurrence, as well as highlighting any unusual clusters of such diseases. Timely and appropriate intervention can then prevent or control any outbreaks.[6] Such a benefit extends beyond the institution to the wider community, including the families of the children and staff, schools, and hospitals to which these children are admitted.

Approximately 300 infants, children, and adolescents in a residential child care centre have various social problems but no major disabilities. Primary health care service is provided by full-time staff and qualified nurses. Until 2004, outreach physicians from the Maternal and Child Health Centres visited the centre 3 times a week and referred children with acute and more severe illness to the Accident and Emergency Department (AED). Beyond these visits, sick children would also be taken to the AED and admitted if necessary. This hospital is located in the eastern district of Hong Kong, and serves a population that includes approximately 130 000 children younger than 16 years. From 1999 to 2003, there were about 2.8 discharges per 1000 population under 16 years per month from the Department of Paediatrics and Adolescent Medicine of the hospital. We report the pattern of admissions to this department from the centre over a 5-year period.

Table 1. Clinical diagnoses of all respiratory infectious diseases

Diagnosis	No. (%)*
Acute bronchiolitis	83 (44.9)
Other acute upper respiratory tract infections	29 (15.7)
Pneumonia	28 (15.1)
All influenza-related diseases	16 (8.6)
Acute bronchitis	13 (7.0)
Acute otitis media	8 (4.3)
Herpangina	5 (2.7)
Croup	2 (1.1)
Acute pharyngotonsillitis	1 (0.5)
Total	185

* Because of rounding, the percentages do not total 100

Table 2. Aetiologies of all respiratory infectious diseases

Aetiology	No. (%)*
Respiratory syncytial virus	42 (22.7)
Parainfluenza virus	17 (9.2)
Influenza A or B viruses	16 (8.6)
Adenovirus	3 (1.6)
Rhinovirus	2 (1.1)
Haemophilus influenzae	2 (1.1)
Streptococcus pneumoniae	1 (0.5)
Negative microbiological results	65 (35.1)
No microbiological test	37 (20.0)
Total	185

* Because of rounding, the percentages do not total 100

Methods

Data of patients admitted from the centre during the period 1 January 1999 to 31 December 2003 were retrospectively retrieved from the hospital computer medical system. Admission records from the paediatric wards were also checked. Only children aged over 28 days and admitted from the AED were included. Data were recorded for each child's age, sex, date of admission, clinical diagnoses, and duration of hospitalisation. Clinical diagnoses were categorised as infectious or non-infectious and the latter were excluded from analysis. Infections were further classified according to the system affected: respiratory (all influenza-related illnesses or other non-influenza–related illnesses such as acute otitis media, acute sinusitis, acute pharyngotonsillitis, croup, acute bronchitis, acute bronchiolitis, pneumonia, other acute upper respiratory tract infections, etc), gastro-intestinal (eg acute gastroenteritis), renal (eg urinary tract infection), neurological (eg meningitis), soft tissue (eg cellulitis), viral exanthema (eg varicella, roseola infantum), and others. In cases of multiple clinical diagnoses of infection in the same episode, the primary diagnosis was recorded. Results of microbiological investigations such as nasopharyngeal aspirate for respiratory viruses, sputum culture, culture from blood or other sterile sites, and serology for viral or bacterial aetiology were also recorded. Any clusters of infectious disease were identified by analysis of the admission dates.

Data were analysed using Microsoft Excel (Windows 2000; Microsoft Inc, US) and the Statistical Package for the Social Sciences (Windows version 11.5; SPSS Inc, Chicago [IL], US). The study was approved by the Ethics Subcommittee of the Pamela Youde Nethersole Eastern Hospital.

Results

From 1 January 1999 to 31 December 2003, 267 children from the centre were admitted to our department. Admissions from the AED accounted for 236 children, of whom 221 (93.6%) had an infectious disease(s). Their ages ranged from 1 to 148 months (median, 10; mean, 15.2; standard deviation [SD], 16.5 months) and boys (57.5%) outnumbered girls. Hospital stay varied from 2 to 53 days (median, 5; mean, 6.1; SD, 4.7 days).

Respiratory infection was present in 185 (83.7%) children. Of the remaining 36 children, viral exanthema was diagnosed in 7.2%, gastro-intestinal infection in 5.9%, renal infection in 2.3%, soft-tissue infection in 0.5%, and other infections in 0.5%. Among the 185 children with respiratory infection, most had acute bronchiolitis (44.9%), other acute upper respiratory tract infections (15.7%), or pneumonia (15.1%). All influenza-related infections accounted for 8.6% (Table 1). Microbiological testing was performed in 148 (80.0%) children: 83 (44.9%) had positive microbiological results and 80 (43.2%) had positive viral results, all from nasopharyngeal specimens. Most had

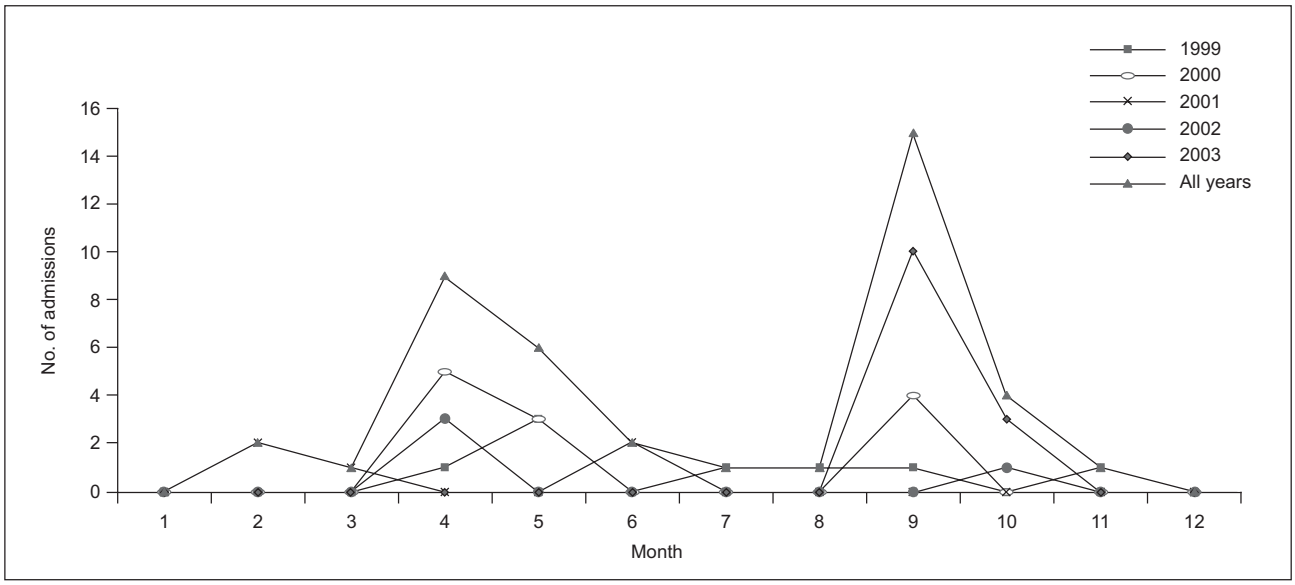

Fig 1. Annual distribution of admissions with respiratory syncytial virus

respiratory syncytial virus (RSV) [22.7%], parainfluenza virus (9.2%), or influenza A or B viruses (8.6%) [Table 2].

Peaks of admission with RSV were observed between April to May and September to October: 13 (31%) of all 42 patients admitted were within a 1-month period from 8 September to 8 October 2003 (Fig 1). Their mean age was 13.2 (SD, 14.8) months. Nine were aged 2 to 7 months, and four were aged 22 to 50 months. There were seven cases of acute bronchiolitis, two cases of acute bronchitis, two cases of pneumonia, and two cases of acute upper respiratory tract infection. The dates of admissions during this period are shown in Fig 2. They were hospitalised for 8.1 (SD, 3.3) days. When compared with the other 29 children with RSV out of this period (mean age [SD], 10.3 [9.3] months; length of hospitalisation, 8.0 [5.0] days), there was no statistically significant difference (by Mann-Whitney *U* test) in age (P=0.935) or length of hospital stay (P=0.518).

There were no or at most three cases of parainfluenza virus infection each month except in December 2003, when seven (41%) of all 17 cases presented (Fig 3). They aged 6 to 12 months with a mean of 8.1 (SD, 2.4) months. They were admitted on the 1st (n=3), 5th (n=2), and 7th (n=2) of December 2003. Six children had acute bronchiolitis and one had pneumonia. All had parainfluenza virus type 3. They were hospitalised for 8.9 (SD, 3.2) days. When compared with the other 10 children with parainfluenza virus out of this period (mean age [SD], 13.2 [14.4] months; length of hospitalisation, 5.9 [2.1] days), they appeared to be younger and stayed longer but the difference did not reach statistical significance shown by Mann-Whitney *U* test (P=0.883 for age and P=0.055 for length of hospital stay).

There were 16 cases of influenza over the 5-year period, none in the months from April to December except in August 2001, when there were two cases. From January to March, there were no or at most three cases each month except in January 2002, when there were six cases (Fig 4). They aged from 16 to 26 months. All were influenza A and subtype results revealed them to be all H3N2.

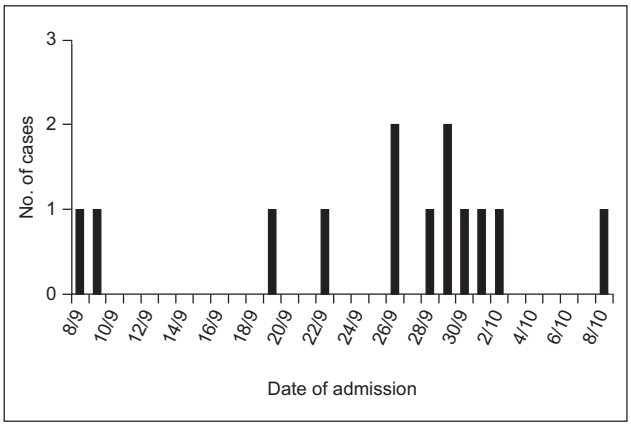

Fig 2. Cases of respiratory syncytial virus presented between 8 September and 8 October 2003

Sixteen (7.2%) children were admitted with viral exanthema: 13 roseola infantum, one varicella, one infectious mononucleosis, and one non-specific viral rash. There was no or at most one case of roseola infantum each month except in January 2001 and September 2001, when there were two cases each month. In both instances, children were admitted 14 to 15 days apart.

There were 13 cases of gastroenteritis: one was confirmed to be rotavirus and one norovirus. There was no or at most one case each month except in October 2001, when there were two cases, admitted 15 days apart.

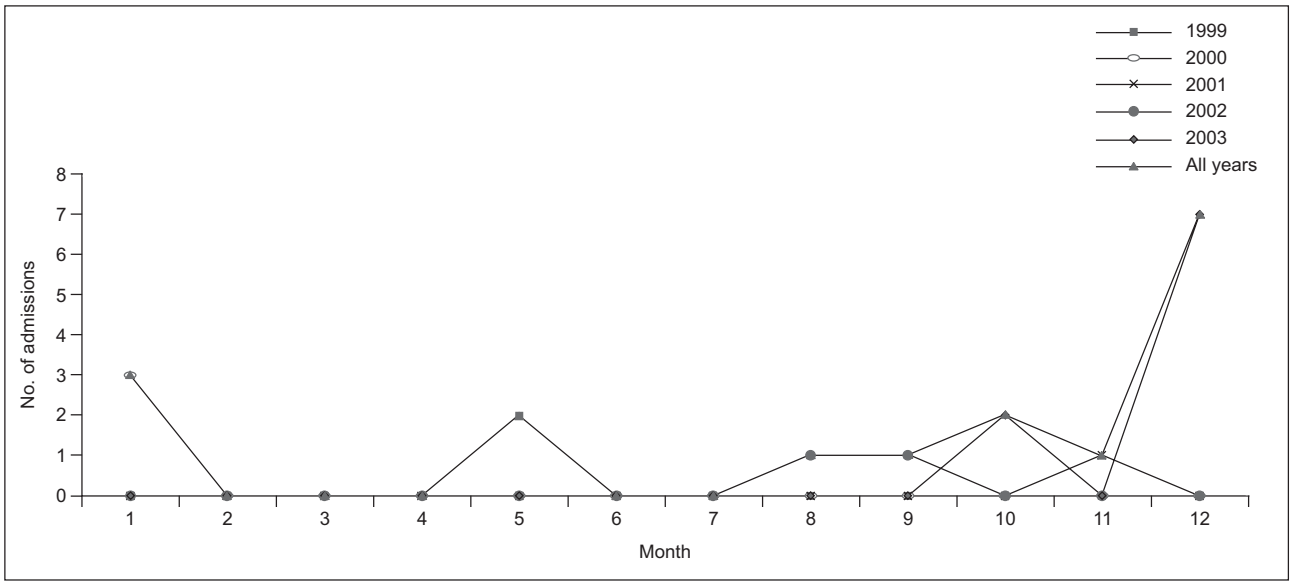

Fig 3. Annual distribution of admissions with parainfluenza virus infection

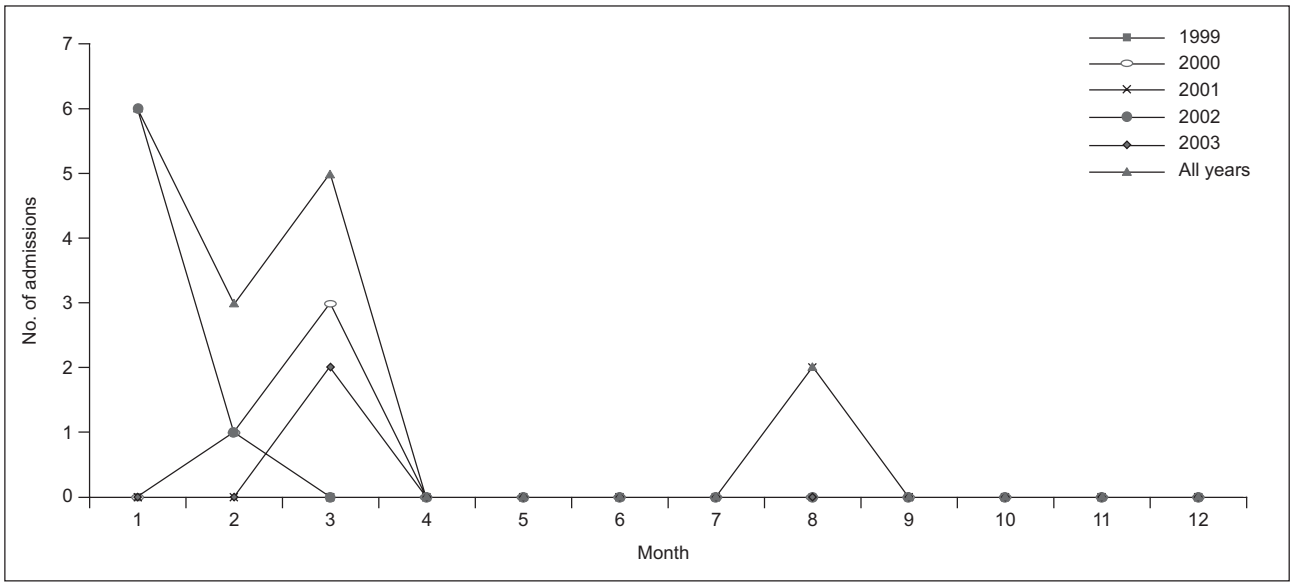

Fig 4. Annual distribution of admissions with influenza infection

Discussion

The residential child care centre is a relative small community but consumes a significant proportion of health care services. Admissions from the centre to our department contributed to about 1.2% of all admissions, approximately 4.5 per month. Assuming that the number of children in the centre remained static at 300, there were 14.8 episodes per 1000 children per month. This admission rate is about 5 times greater than that from the general paediatric population of the region. Most children were admitted with an infectious disease(s), most often respiratory tract infection. The most common pathogen was RSV and children were hospitalised for a mean of 6 days. Data for children not at the centre were not available for comparison.

Infectious diseases occur more commonly among children who attend day-care centres than those who are cared for at home. They have 51% more episodes of infection, 134% more days of illness, and 1.4 to 1.8 times more medical consultations for acute infection.[7] Children under 12 months had 6.3 to 9.9 respiratory infections per year.[7] They were also at greater risk for common colds (relative risk=1.7), otitis media (2.0), and pneumonia (9.7), that were all statistically significant for children younger than 1 year.[1] Day-care centre attendance was also a risk factor for admission with lower respiratory tract infection

in children aged under 2 years (odds ratio=3.0). The respiratory tract is the most common site of infection, and accounts for 89% of disease episodes.[8] Our results compare well with this figure as well as results of another study that demonstrated RSV as the most common aetiology for respiratory tract infection.[7]

Infections in children in child day-care centres have been a concern since the 1980s. Host and immunological factors have been thought to be important in the transmission and development of infectious diseases among these children. The young age of children was particularly significant because of their specific immunological or physiological characteristics. In addition to the risk of air-borne and respiratory droplet infection within a closed environment, age-specific behaviour such as personal hygiene, use of nappies, and 'mouthing' behaviour may increase the risk of sharing infectious organisms by direct or indirect contact, via staff's and their own hands, and fomites contaminated with respiratory secretions, urine, and stool. In addition, environmental factors may be important, for example the higher the number of children in the centre, the higher the risk of infections. Mixing of children with different ages may also cause more infections in certain groups of children, for example transmission of enteric infections to toilet-trained children who socialise with non–toilet-trained children.[9]

Other physical characteristics of the premises such as distance between beds, number of beds in each room, ventilation, water supply, waste and sewage disposal, toilet and food preparation facilities are important considerations in infection control. Staff-to-children ratio and adherence to good infection control practices are also crucial.

The setting of our study was a residential rather than a child day-care centre. It was reasonable to assume that the risk of infection would be greater as some of the risk factors found in non-residential centres would be inflated. Children stay together day and night so there is higher opportunity for transmission of infection through direct contact and sharing of facilities. A further threat lies in children who become sick but do not require hospitalisation, and who are nursed at the centre. In a non-residential centre, such children would likely be excluded.

The population of the residential child care centre in this study may be too small to establish any epidemiological or seasonal patterns of different infectious diseases in our community. We have nonetheless identified several interesting findings. It was estimated that the annual incidence of hospital admission with RSV was approximately 28 per 1000 children. This is comparable with the figures from the US for children under 6 months old (31 per 1000).[10] However, the pattern of RSV occurrence may not be well explained by the reported epidemiology. In 1998 to 1999, RSV was more common from February to September in Hong Kong[11] and from October to February in the US.[10] In this case review, more RSV cases were admitted in September to October 2003. The first two cases were admitted on 8 to 9 September and subsequently discharged back to the centre on 12 and 15 September, respectively. Eleven cases were subsequently admitted from 19 September to 8 October. This unusual cluster of admissions raised concern among hospital paediatricians, who reported the phenomenon to the hospital control team and local public health officials. In addition, they visited the centre in an attempt to identify any problems. They discovered that more children than expected had respiratory symptoms although they were insufficient to require hospital admission. Infection control measures within the centre were consequently increased. The period of RSV viral shedding is typically 1 week although up to 3 weeks have been documented.[12] Thus children may have continued to spread the virus after hospital discharge back to the centre. After the first few cases of admission, repeated nasopharyngeal aspirates for virology were performed and children were discharged only if they were medically fit and test results were negative. Nonetheless it is uncertain whether such tests are sufficiently sensitive to exclude the viral shedding and whether this practice will benefit the control of RSV infection in a child day-care centre. We observed no delay in the discharge of patients following introduction of the additional testing although data were not available on the duration of hospitalisation for children with RSV who were not at the centre.

Reported seasonal differences of parainfluenza virus infection were not clearly evident.[13] A cluster of cases among patients in the centre was observed in December 2003. Staff at the centre reported no increase in the number of symptomatic residents and they were discharged according to usual practice. Nevertheless staff at the centre were informed of their clinical problems so that they could closely monitor the situation.

The annual admission rate of children from the centre for influenza was approximately 10.4 per 1000 children. This was comparable with the local data that revealed annual rates of influenza-related admissions of about 0.8 to 28 per 1000 children in different age-groups during 1998 to 1999.[11] A cluster in the centre in January 2002 was identified retrospectively and was compatible with the expected peak seasons evidenced by previous local and overseas reports.[10,11,13]

This study demonstrated that the annual incidence of admission for gastroenteritis was about 22 per 1000 children, lower than the reported rate of 1.0 to 1.4 episodes per child per year.[7] A previous study has reported 0.8 to 3.0 outbreaks per day-care centre per year.[2] Our study revealed no outbreaks of gastroenteritis.

In this study, we were only able to identify children who were admitted to the hospital and could not establish the epidemiology of various infectious diseases among all children in the residential day-care centre, particularly milder

illnesses such as mild gastroenteritis, upper respiratory infection, and otitis media. More useful information would be provided by basic surveillance activities that include daily health screening by on-site staff and active surveillance provided by the public health agency. Such interventions may help detect disease outbreaks earlier and initiate more effective infection control measures.[6]

Interpretation of the clusters of RSV in September to October 2003 and parainfluenza virus in December 2003 was not straightforward. Several other additional factors made this task complicated—we were unaware of the usual number of cases of RSV and parainfluenza virus in the centre because not all children would have necessarily been admitted to our hospital; it was unclear if there was a change in the experience and practice of referral by the on-site and outreach health care providers; our practice of performing diagnostic investigations for hospitalised children may have changed; and advancing technology may have improved the sensitivity of diagnostic tests. We can only be certain about our own practice of performing the investigations: the proportion of microbiological tests throughout the years was quite high (80.0%) and was similar in the period of September to October 2003 and December 2003 (85.7% and 77.8%, respectively). Based on our estimation of more symptomatic children in the centre in these two periods, we believe that an outbreak of RSV infection did occur during that period.

The outbreak of RSV was investigated by public health officials. Hospital paediatricians frequently advised public health officials, the hospital infection control team, and staff at the centre about the progress of the hospitalised children. Such communication and cooperation are essential in the management of community outbreaks of infection. Professional advice, as well as financial, administrative, and legislative support should also be available to help day-care centres implement infection control policies. More surveillance is also necessary to understand the epidemiology of RSV and determine effective infection control measures in day-care centres.

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