ORIGINAL ARTICLE

Assessing disease burden of respiratory disorders in Hong Kong children with hospital discharge data and linked laboratory data

Edmund AS Nelson
John S Tam 談兆麟
LM Yu 俞麗媚
Albert M Li 李民瞻
Paul KS Chan 陳基湘
Rita YT Sung 宋銀子

Objectives To describe the pattern of respiratory disorders in the Hong Kong paediatric population admitted to government hospitals, and to assess the reliability of the diagnoses by linkage with laboratory data.

Methods Discharge diagnoses for all admissions are recorded in a central computerised database, the Clinical Management System. These data were analysed for the inclusive period July 1997 to June 1999. Virology laboratory results from a single hospital were linked to the Clinical Management System diagnostic codes to examine discrepancies in coding specific viral aetiologies.

Results A primary diagnosis of a respiratory disorder was noted in 37.5% (upper respiratory 30.1%, tonsillitis/pharyngitis 10.5%, croup/laryngitis 2.3%, acute otitis media 2.7%, bronchitis/chest infection 2.6%, bronchiolitis 10.2%, pneumonia 20.9%, influenza 4%, asthma and allergic rhinitis 16.5%), and a primary or secondary diagnosis in 42.5% of children younger than 15 years. The incidence rates of respiratory illness coded as bronchiolitis and influenza were respectively estimated to be 887-979 and 222-381 per 100 000 children under 5 years and 3551-3949 and 415-528 per 100 000 children under the age of 1 year. The percentage of respiratory-associated admissions varied significantly by hospital and detailed analysis of data at one hospital highlighted important discrepancies between discharge diagnosis and laboratory results.

Conclusions These passive surveillance data provide general estimates of the disease burden for respiratory disorders in Hong Kong children. Active surveillance studies are required to provide more accurate estimates of the disease burden. Consideration should be given to enhance the Clinical Management System by routinely linking all laboratory data with discharge diagnosis information, by establishing sentinel surveillance hospitals and by assessing new strategies to standardise coding.

Key words
Hong Kong; Pediatrics; Respiration disorders

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The Chinese University of Hong Kong, Prince of Wales Hospital, Shatin, Hong Kong:
Department of Paediatrics
EAS Nelson, MB, ChB, MD
AM Li, MB, ChB, MRCPCH
RYT Sung, FRCPCH, MD
Department of Microbiology
PKS Chan, MB, BS, MD
Wyeth Vaccine Research, Pearl River, New York, United States
JS Tam, PhD, MSc
Centre for Statistics in Medicine, University of Oxford, Oxford, United Kingdom
LM Yu, MSc

Correspondence to: Prof EAS Nelson
E-mail: tony-nelson@cuhk.edu.hk

Introduction

In Hong Kong, respiratory disorders are a leading cause of admission to general paediatric wards, especially for children aged up to 3 years.[1,2] A number of studies on patterns of respiratory disorders in children have been undertaken in the South-East Asian region. In Taiwan respiratory tract disease accounted for 28.8% of all paediatric admissions to 24 major hospitals.[3] Tay et al[4] reviewed the monthly admissions of children over 10 years with common illnesses to a Singapore hospital and found that most respiratory tract diseases had significant seasonal variations. A study undertaken at one hospital in Hong Kong noted that 6.6% of all paediatric admissions were due to bronchiolitis.[5] The same group, in a separate study, found that pneumonia requiring admission to hospital had an incidence of 6.4 per 1000 children per year.[6] A study using an excess-hospitalisation strategy showed that admission rates in Hong Kong for influenza were 3 to 10 times as high as those reported for children in the United States.[7] These inferences were derived using a central computerised database for all Hong Kong government hospitals and virological data from a single hospital, and based on estimates of excess hospitalisation and on the fact that peaks for influenza and respiratory syncytial virus (RSV) may be well-separated.[8] The central computerised database known as the Clinical Management System (CMS) contains

standardised discharge data on all patients admitted to Hong Kong's publicly funded government hospital system, referred to as the Hospital Authority (HA). Twelve of these HA hospitals have paediatric beds and are estimated to provide 90% of all in-patient paediatric care in the Hong Kong Special Administrative Region. We used this data source to examine all respiratory-related admissions to estimate the disease burden for these conditions as a proportion of all general paediatric admissions for children under the age of 15 years, over the 2-year period 1 July 1997 to 30 June 1999 inclusive. Data from a single hospital were then used to link actual virology laboratory results to discharge diagnostic codes provided by the CMS. Incidence rates for influenza, bronchiolitis, and respiratory disorders were estimated for children under 5 years old.

透過分析醫院的病人出院數據和相關的化驗數據，評估香港兒童患呼吸系統疾病的情況

目的 了解政府醫院兒科病人患呼吸系統疾病的模式，和透過化驗的數據評估診斷的可信度。

方法 所有入院者的出院診斷資料都記錄在中央電腦數據庫「臨床管理系統」內。是次研究分析此系統內1997年7月至1999年6月的資料，並將其中一間醫院的病毒化驗結果與「臨床管理系統」的診斷編碼相連，藉此檢查對特殊病毒性病因的編碼是否出現差異。

結果 對15歲以下的兒童，有37.5%之初級診斷為呼吸系統疾病（上呼吸道問題30.1%，扁桃腺炎/咽頭炎10.5%，哮吼/喉炎2.3%，急性中耳炎2.7%，支氣管炎/肺部感染2.6%，細支氣管炎10.2%，肺炎20.9%，感冒4%，哮喘和過敏性鼻炎16.5%），而初級和第二級診為呼吸系統疾病的數字共達42.5%。編碼為「細支氣管炎」和「感冒」病症，五歲以下兒童的發生率分別為每十萬人887至979人和222至381人；而一歲以下兒童的發生率則分別為每十萬人3551至3949人和415至528人。各醫院間因呼吸系統疾病而入院的病人比率有明顯差異，而對詳細分析其中一間醫院的數據時，更發現醫院的出院診斷和化驗結果之間有重大差異。

結論 是次被動式調查所得的數據，提供了香港兒童患呼吸系統疾病情況的普遍評估，若要獲得準確的患病情況估計，則須作主動式的監察研究。「臨床管理系統」應考慮提升功能，包括化驗數據與出院診斷的連線應成為常規做法、將部分醫院設定為預警監察醫院和將疾病編碼統一。

Methods

Sources of data

From 1996 the CMS was introduced to collect uniform discharge and other information on all patients admitted to all HA hospitals throughout Hong Kong. The information collected included patient identifiers, date of birth, sex, a maximum of 15 diagnoses and 15 procedures (classified according to the International Classification of Diseases [ICD9-CM] codes), and admission and discharge dates. Paediatric patients with medical and surgical conditions are admitted to separate wards of government hospitals in Hong Kong. A database of all general paediatric patients hospitalised in the medical wards at the 12 government hospitals admitting such patients from 1 July 1997 to 30 June 1999 was provided by the HA. Neonatal admissions were not included in the analysis.

Assessment of respiratory-associated hospitalisations

The ICD9-CM codes classified respiratory-associated hospitalisations into upper respiratory tract infections, pharyngitis and tonsillitis, croup and laryngitis, otitis media, bronchitis and non-specific chest infection, bronchiolitis, bronchiolitis due to RSV infection, pneumonia, influenza, asthma and allergic rhinitis (see Appendix for coding details). Respiratory-associated admissions were assessed as a proportion of total paediatric admissions and by sex, month of admission, and hospital.

Linking of Clinical Management System with laboratory data for the Prince of Wales Hospital

All admissions from one of the HA hospitals—Prince of Wales Hospital—were matched with a unique hospital number with identifier information available within the paediatric department's audit system. A total of 16 844 general paediatric admissions under the age of 15 years that had been admitted during the corresponding period could be matched. Although these departmental audit data were derived from the CMS, there were a small number of discrepancies in discharge diagnoses between the two data sources (presumably as a result of changes made after data had been downloaded). These matched data were then linked with the laboratory data. There were 57 351 laboratory tests from 7310 subjects that had a valid unique hospital number and of these 29 349 had a hospital number that could be matched with those of children in the CMS database containing the discharge diagnoses. Those laboratory tests with no hospital number were matched with the subject's unique Hong Kong identity number, which gave an additional 54 tests, ie a total of 29 403 tests. A proportion of tests had no admission date (n=205), a collection date before hospital admission date (n=6859), and a collection date after hospital discharge date (n=790). Tests with a collection date outside hospital stay were further examined and 3509 tests were found to have mismatched hospital numbers that were corrected. The final number of tests was 25 058 from a total number of 4160 subjects. The normal laboratory practice would be to test nasopharyngeal aspirate specimens for influenza A, influenza B, and RSV by immunofluorescence followed by virus isolation for all respiratory viruses. Blood specimens would be screened for influenza A;

TABLE 1. Respiratory-associated hospitalisations by reported diagnosis among 159 626 children aged 0-15 years in government hospitals from 1 July 1997 to 30 June 1999

Respiratory-associated hospitalisations	International Classification of Diseases codes	Primary diagnosis* No. (%)	Any diagnosis† No. (%)	All diagnoses‡ No. (%)	Female:male %:%
Upper respiratory infection	460-461.9, 465-465.9, 786.2	18 046 (30.1)	21 802 (32.2)	23 078 (34.1)	45:55
Tonsillitis/pharyngitis	462-463.9, 034.0, 474.11	6311 (10.5)	7369 (10.9)	7698 (11.4)	41:59
Croup/laryngitis	464-464.9, 786.1	1394 (2.3)	1422 (2.1)	1483 (2.2)	32:68
Acute otitis media	381-382.9	1625 (2.7)	2026 (3.0)	2604 (3.8)	37:63
Bronchitis/chest infection	466-466.09, 490-490.9, 519.8	1546 (2.6)	1659 (2.4)	1909 (2.8)	38:62
Bronchiolitis§	466.1-466.9	6081 (10.2)	6432 (9.5)	6818 (10.1)	34:66
Pneumonia	480-486.9, 507.0	12 541 (20.9)	13 375 (19.7)	14 925 (22.0)	45:55
Influenza	487-487.9	2418 (4.0)	2792 (4.1)	3053 (4.5)	42:58
Asthma/allergic rhinitis	493-493.9, 477-477.9	9908 (16.5)	10 893 (16.1)	12 358 (18.2)	34:66
Total respiratory diseases	All above codes	59 870 (37.5)	67 770 (42.5)	-	41:59
All other diseases	All other codes	99 756‖ (62.5)	-	-	45:55

* **Primary diagnosis code only**

† **Any of 15 possible diagnosis codes, with category selected hierarchically when more than one respiratory-related code was used, ie first diagnostic code would take precedence over the second and so on**

‡ **Total admissions with a particular diagnostic category (total percentage as proportion of respiratory admissions is more than 100% as the number of admission had more than one respiratory diagnostic code)**

§ **No. of primary diagnosis of respiratory syncytial virus bronchiolitis=1125 (1.9% of all respiratory-associated admissions)**

‖ **715 Uncoded**

influenza B; RSV; parainfluenza 1, 2 and 3; adenovirus; and mycoplasma, ie a total of eight tests. Results were considered positive if there was either a positive viral culture, a four-fold or greater rise in titre, or a single titre of greater than 80.

Results

During the 2-year study period, 169 082 children were admitted to the general medical paediatric wards of HA hospitals; 94% (159 677) were under the age of 15 years and 63% (106 919) were under the age of 5 years. A total of 2720 different ICD codes were used. Causes of respiratory morbidity were assessed for admissions of children younger than 15 years. Respiratory disorders were coded as the primary diagnosis in 37.5% of admissions, and as the primary or as one of any 14 secondary diagnoses in 42.5% (Table 1). The percentage of all discharges with a primary respiratory diagnosis ranged from 20.0 to 53.8% in the 12 HA hospitals (Table 2).

The percentage of all respiratory-associated discharges listed with a primary code for bronchiolitis, RSV bronchiolitis, and influenza ranged from 2.2 to 6.5%, 0.1 to 2.0%, and 0.0 to 6.1% respectively in the 12 HA hospitals (Table 2). Males outnumbered females (59% versus 41%, Table 1) for all respiratory admissions, and for most respiratory sub-categories.

Of all the respiratory sub-categories, children with a diagnosis of bronchiolitis, influenza, and pneumonia had the longest median stay in hospital of 3 days (interquartile range [IQR], 2-5 days), whereas the other sub-categories had a median stay of 2 days. The median age of children with bronchiolitis was 8 (IQR, 5-13) months, which was less than those with croup/laryngitis (16 [11-23] months), upper respiratory tract infection (23 [8-47] months), otitis media (24 [14-40] months), influenza (28 [13-50] months), bronchitis/chest infection (34 [22-53] months), tonsillitis/pharyngitis (37 [18-59] months), pneumonia (40 [22-65] months), and asthma/allergic rhinitis (59 [38-100] months). Twenty-two deaths were recorded in these respiratory-associated hospitalisations. These deaths were coded as pneumonia (adenovirus=1, *Haemophilus influenza*=1, influenza=1, pseudomonas=1, RSV=2, staphylococcal=1, unspecified=10), bronchiolitis (RSV=1, parvovirus B19=1), status asthmaticus (n=2), and acute upper respiratory tract infection (n=1) [Table 3]. Overall, 12 of the deaths were associated with codes suggesting neurological complications such as severe mental retardation, epilepsy, Werdnig-Hoffmann disease, and other significant medical conditions.

The annual incidence (hospitalisation) rates per 100 000 for respiratory illnesses coded as bronchiolitis, RSV bronchiolitis, and influenza (primary diagnosis only) were estimated for 1997 and 1998 (Table 4). Respective hospitalisation rates for respiratory illnesses coded as bronchiolitis were 887-979 for children under 5 years, and 3551-3949 for those under the age of 1 year. Rates for admissions classified specifically as RSV bronchiolitis were 90-259 per 100 000 children under 5 years, and 381-1134 per 100 000 children under 1 year. Corresponding rates for influenza were 222-381 in children under 5 years, and 415-528 for those under 1 year.

The analysis of data linking discharge diagnoses with laboratory data for the single hospital showed

TABLE 2. Hospital admissions of all respiratory illnesses (n=59 870), bronchiolitis, respiratory syncytial virus (RSV) bronchiolitis, and influenza as a percentage of all admissions (n=159 626) based on primary diagnostic code only (1°) or any of 15 possible diagnostic codes (2°), among children aged 0-15 years in Hospital Authority hospitals from 1 July 1997 to 30 June 1999

Hospital	Respiratory illness (%)	Bronchiolitis		RSV bronchiolitis		Influenza	
		1° (%)	2° (%)	1° (%)	2° (%)	1° (%)	2° (%)
A	47.8	3.9	5.4	0.6	0.8	1.5	2.3
B	34.3	3.1	3.7	0.5	0.6	0.0	0.0
C	40.7	5.0	5.1	0.1	0.1	1.3	1.4
D	48.5	3.9	4.6	2.0	2.3	0.3	0.7
E	30.0	3.2	3.7	0.4	0.5	0.3	0.4
F	33.3	4.1	4.5	0.9	1.1	0.7	0.9
G	53.8	5.4	5.9	1.0	1.1	6.1	7.0
H	32.4	3.2	4.0	0.8	1.0	1.6	2.3
I	20.0	2.2	2.4	0.8	0.8	3.3	4.6
J	38.5	3.2	3.5	0.5	0.5	0.1	0.1
K	44.9	6.5	7.2	1.4	1.4	1.4	1.6
L	53.7	2.9	3.2	0.8	0.8	2.4	2.9
Total	**37.5**	**3.8**	**4.3**	**0.7**	**0.8**	**1.5**	**1.9**

TABLE 3. Main outcomes for all respiratory illnesses, bronchiolitis, respiratory syncytial virus (RSV) bronchiolitis and influenza—for all hospital admissions based on primary diagnostic code only (1°) or any of 15 possible diagnostic codes (2°), among children aged 0-15 years in Hospital Authority hospitals from 1 July 1997 to 30 June 1999

Outcome	Respiratory illness (No.)	Bronchiolitis (No.)		RSV bronchiolitis (No.)		Influenza (No.)	
		1°	2°	1°	2°	1°	2°
Deaths	22	2	7	1	1	1	6
Home with follow-up	32 024	3386	3930	656	763	1136	1541
Home	26 526	2560	2728	456	475	1245	1460
Discharge against medical advice	1207	116	123	10	10	34	39
Transfer	66	14	27	2	5	1	6
Other	25	3	3	0	0	1	1
Total	**59 870**	**6081**	**6818**	**1125**	**1254**	**2418**	**3053**

TABLE 4. Absolute numbers and respective incidence rates (IRs) per 100 000 shown in parenthesis for children under the age 5 years (0-59 months) for bronchiolitis, bronchiolitis due to respiratory syncytial virus (RSV) infection, influenza, and all respiratory disorders

Age-group (months)	No. of children*		No. with bronchiolitis† (IR)		No. with RSV bronchiolitis† (IR)		No. with influenza† (IR)		No. with any respiratory diseases† (IR)	
	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998
0-11	59 250	52 977	2340 (3949)	1881 (3551)	226 (381)	601 (1135)	313 (528)	220 (415)	7500 (12 658)	6541 (12 347)
12-23	63 291	59 250	744 (1176)	736 (1242)	54 (85)	144 (243)	353 (558)	188 (317)	5412 (8551)	4796 (8095)
24-35	68 637	63 291	139 (203)	138 (218)	17 (25)	54 (85)	226 (329)	138 (218)	4511 (6572)	3770 (5957)
36-47	71 646	68 637	35 (49)	33 (48)	3 (4)	17 (25)	255 (356)	88 (128)	4049 (5651)	3910 (5697)
48-59	70 451	71 646	6 (9)	12 (17)	0 (0)	3 (4)	122 (173)	68 (95)	2600 (3691)	2622 (3660)
Total	**333 275**	**315 801**	**3264 (979)**	**2800 (887)**	**300 (90)**	**819 (259)**	**1269 (381)**	**702 (222)**	**24 072 (7223)**	**21 639 (6852)**

* **Based on the number of live births from Hong Kong Census data**

† **Primary diagnosis only; IR denotes incidence rate per 100 000 children under the age of 5 years**

significant discrepancies between the actual diagnoses and laboratory results, for the 33.5% (n=5639) of general paediatric admissions with a primary respiratory-associated diagnosis (Table 5). There were 115 children that had a primary CMS discharge diagnosis of influenza and 161 had 'any' diagnosis of influenza. Laboratory

TABLE 5. Respiratory-associated hospitalisations by reported diagnosis from Clinical Management System among 16 844 children aged under 15 years admitted to the Prince of Wales Hospital from 1 July 1997 to 30 June 1999 compared with actual results from the virology laboratory for patients who had specimens sent for virus testing

Primary diagnosis only	No.	Influenza	
		Sent % (No.)	Positive % (No.)
Upper respiratory infection	1929	39.7% (766)	33.2% (254)
Tonsillitis/pharyngitis	185	33.5% (62)	6.5% (4)
Croup/laryngitis	208	24.0% (50)	20.0% (10)
Acute otitis media	78	28.2% (22)	18.2% (4)
Bronchitis/chest infection	184	30.4% (56)	3.6% (2)
Bronchiolitis	698	44.8% (313)	6.1% (19)
Pneumonia	846	44.4% (376)	6.6% (25)
Influenza	115	49.6% (57)	91.2% (52)
Asthma/allergic rhinitis	1396	13.7% (191)	5.8% (11)
Other diseases	11 205	11.9% (1338)	9.4% (126)
Total	16 844	19.2% (3231)	15.7% (507)
Any of 15 possible discharge diagnoses			
Any influenza (International Classification of Diseases [ICD] 487-487.99)	161	51.6% (83)	92.8% (77)
Any bronchiolitis (ICD 466.1-466.9)	760	43.9% (334)	6.0% (20)
Any RSV bronchiolitis (ICD 466.11)	179	43.0% (77)	0% (0)
Any RSV infection (ICD 466.11, 480.1, 079.6)	215	45.1% (97)	3.1% (3)
Any parainfluenza (ICD 480.2)	7	(2)	(0)
Any adenovirus (ICD 480.0, 079.0)	34	(19)	(0)

confirmation of influenza was only available in 52 and 77 respectively (Table 5). However overall, 507 admissions had influenza identified and 126 of these had a non-respiratory primary diagnosis. Influenza was isolated from 254 patients with a primary diagnosis of upper respiratory infection (13% of all admissions classified as upper respiratory tract infection), 10 patients with croup or laryngitis, 19 patients with bronchiolitis, 25 with pneumonia, and 11 with asthma or allergic rhinitis. There were 698 children with a primary diagnosis of bronchiolitis, 760 with 'any' diagnosis of bronchiolitis and 179 of these 760 with a specific diagnosis of RSV bronchiolitis (Table 5). The laboratory data showed that 319 admissions had RSV identified but only 76 of these patients had diagnoses that were specifically coded as RSV bronchiolitis; 71 admissions with RSV isolated had a non-respiratory primary diagnosis. Overall there were 1101 patients who had any respiratory organism identified (influenza A, influenza B, RSV, parainfluenza 1, 2 or 3, adenovirus or mycoplasma) and of these 294 were in-patients who had a non-respiratory primary diagnosis and 381 were in children with a primary diagnosis of upper respiratory tract infection. A total of 50% (58/115) of children that had 'any' diagnosis of influenza infection did not in fact have either a positive or negative result from the virology laboratory. Conversely 85% (430/507) of all positive influenza results were in children that did not have any CMS diagnosis indicating influenza infection. Overall 34% (1893/5639) of patients with respiratory-associated primary diagnosis and 12% (1338/11 205) with a non-respiratory primary discharge diagnosis had a specimen sent for influenza testing with 20% (381/1893) and 9.4% (126/1338) respectively being positive. Likewise for RSV bronchiolitis, there were 55% (385/698) with this diagnosis who did not in fact have either a positive or negative result from the virology laboratory. Conversely 76% (243/319) of all positive RSV results were in children that did not have any CMS diagnosis indicating RSV bronchiolitis. Overall 33% (1886/5639) of patients with a respiratory-associated primary diagnosis and 12% (1317/11 205) with a non-respiratory primary discharge diagnosis had a specimen sent for RSV testing; of these 13% (248/1886) and 5.4% (71/1317) respectively were positive.

Based on the data for children with a respiratory disorder, a CMS influenza discharge diagnosis had a positive predictive value of 48% that the laboratory result would be positive for influenza and a negative predictive value of 93% that the result would be negative or not reported. Based on the data for those children with a respiratory disorder, a CMS RSV discharge diagnosis had a positive predictive value of 42% that the laboratory result would be positive for RSV and negative predictive value of 96% that the result would be negative or not reported. Extrapolating from these data, it is possible that

Respiratory syncytial virus (RSV)		Parainfluenza		Adenovirus	
Sent % (No.)	Positive % (No.)	Sent % (No.)	Positive % (No.)	Sent % (No.)	Positive % (No.)
39.9% (769)	5.7% (44)	39.6% (763)	6.2% (47)	39.8% (767)	5.0% (38)
33.5% (62)	1.6% (1)	33.5% (62)	1.6% (1)	33.5% (62)	27.4% (17)
24.0% (50)	14.0% (7)	24.0% (50)	16.0% (8)	24.0% (50)	0.0% (0)
28.2% (22)	9.1% (2)	28.2% (22)	4.5% (1)	28.2% (22)	9.1% (2)
31.0% (57)	17.5% (10)	30.4% (56)	3.6% (2)	30.4% (56)	3.6% (2)
45.0% (314)	46.2% (145)	44.8% (313)	2.9% (9)	44.8% (313)	0.6% (2)
42.9% (363)	7.2% (26)	42.8% (362)	5.0% (18)	44.4% (376)	5.9% (22)
49.6% (57)	1.8% (1)	49.6% (57)	5.3% (3)	49.6% (57)	0.0% (0)
13.8% (192)	6.3% (12)	13.6% (190)	3.2% (6)	13.7% (191)	2.1% (4)
11.8% (1317)	5.4% (71)	11.7% (1310)	2.2% (29)	12.1% (1360)	5.1% (70)
19.0% (3203)	10.0% (319)	18.9% (3185)	3.9% (124)	19.3% (3254)	4.8% (157)
51.6% (83)	1.2% (1)	51.6% (83)	3.6% (3)	51.6% (83)	0% (0)
44.1% (335)	47.5% (159)	43.9% (334)	2.7% (9)	43.9% (334)	0.9% (3)
43.0% (77)	98.7% (76)	43.0% (77)	0% (0)	43.0% (77)	1.3% (1)
45.1% (97)	97.9% (95)	45.1% (97)	0% (0)	45.1% (97)	1.0% (1)
(2)	(0)	(2)	(2)	(2)	(0)
(19)	(1)	(19)	(0)	(19)	(18)

had a specimen been sent for influenza testing on all patients with a respiratory-associated discharge diagnosis and had the proportion positives been 20%, then 6.7% (1133/16 844) of all general paediatric admissions could have been associated with influenza infection.

Discussion

The CMS, by collecting uniform discharge data for all public HA hospitals in Hong Kong since 1996, has enabled this study to provide total counts for hospitalisations of children younger than 15 years with a range of respiratory disorders. These data emphasise the importance of these disorders in Hong Kong but also demonstrate that RSV, influenza, and other respiratory pathogens may be underreported according to routine discharge diagnoses. This supports the findings of Chiu et al[8] who used this central computerised data source to estimate rates of excess hospitalisation for influenza. Using the primary discharge diagnosis alone, 37.5% of all paediatric admissions under the age of 15 years were due to a respiratory disorder and 4.0% and 10.2% of these respiratory admissions were specifically coded as being due to influenza and bronchiolitis respectively. However linking the CMS discharge diagnoses with the virology laboratory results for children admitted to the Prince of Wales Hospital showed significant discrepancies between the discharge diagnosis and the virology result.

We also identified significant differences in the percentages of respiratory admissions classified as being due to these conditions in different hospitals (Table 2). It is therefore important to acknowledge that discrepancies noted between the virology laboratory results and CMS diagnoses identified in one hospital may also ensue in other hospitals. A previous study suggested that 6.6% of all paediatric admissions to one hospital were due to bronchiolitis.[5] Other studies have shown RSV bronchiolitis and influenza to account for 1 to 16.4% and 3.1 to 5.5% of respiratory diagnoses respectively, among hospitalised children.[9-12] The range in coding for bronchiolitis, RSV bronchiolitis, and influenza among these Hong Kong hospitals may reflect differences in the availability of virus testing, differences in the diagnostic criteria used, or differences in coding practices. For example test results may only be ready after patients are discharged and different hospitals may have different practices regarding how discharge codes are amended. To reduce these inter-hospital discrepancies, it is suggested that positive laboratory results be routinely linked with CMS discharge diagnoses. This would indicate which admissions are associated with a specific potential aetiological agent. Such linkage could enable more accurate estimates to be made of disease burden for specific respiratory pathogens. Another suggested

approach is to designate sentinel hospitals to undertake routine virology and bacteriology on all respiratory admissions, and to use such sentinel data to derive more reliable estimates of disease burdens related to the specific respiratory pathogens.

This study used passive surveillance data from the uniform discharge data from all HA hospitals in Hong Kong. Limitations of such data include the absence of data from private hospitals and the potential unreliability of the codes used. Hong Kong has a dual public and private system for both primary and secondary health care. The CMS data provide no information on admissions to private hospitals or visits to primary care practitioners, either public or private. The incidence estimates in Table 4 do not take into account the number of children admitted to private hospitals (estimated to be approximately 10% of all admissions).[8] The incidence data used the number of Hong Kong births as the denominator. It is recognised that a significant number of children born in Hong Kong travel back and forth between Mainland China and Hong Kong and may live for extended periods on the mainland with their parents or other relatives. Therefore, it is likely that a proportion of Hong Kong–born children who sought medical care while staying on the mainland was not included in these incidence calculations. Countering this effect is the fact that this analysis did not determine the proportion of patients who were readmitted for the same episode of respiratory illness, a factor that would result in the overestimation of the true incidence of respiratory disorders. Also not considered in these incidence calculations is the fact that the number of children immigrate to Hong Kong from the Chinese mainland each year.

The other limitation of the CMS discharge data is the unknown reliability of the ICD coding as highlighted by the comparison of laboratory data with actual discharge codes. These codes are entered by the responsible medical officer and are therefore dependent on the information available at the time of discharge and on the ability of the medical officer to locate the correct diagnosis through the CMS. For example laboratory results may not always be available at the time the discharge diagnosis is entered into the CMS. In some hospitals there may be policies to ensure that diagnosis codes are amended when laboratory results become available. The CMS allows for the ICD code to be entered directly if known. The ICD code then appears with the linked diagnosis, which can then be checked by the doctor. Alternatively, the desired diagnosis can be located by using a keyword search. This process implies that there are likely to be variations in the coding used between medical officers and between hospitals. Standardisation of this process is likely to be difficult, unless the codes are entered by trained coding clerks or by other competent personnel. Thus one possible approach to improve coding accuracy and consistency could be to allow the discharging doctor to write a free text discharge diagnosis/diagnoses and for coding clerks to enter codes later. Despite such limitations, our rates of hospitalisation for clinical bronchiolitis in Hong Kong (887-979/100 000 children under 5 years, and 3551-3949/100 000 children under 1 year) are comparable to those reported in other countries.[9,10,12-14] Likewise our rates of hospitalisation for influenza in Hong Kong (222-381/100 000 children under 5 years, and 415-528/100 000 children under 1 year) are comparable to those reported in other countries.[10] However it is likely that significantly higher rates would be identified by active surveillance.[9]

In conclusion, these Hong Kong data show that respiratory disorders are important causes of hospitalisation of children under the age of 15 years. However, routinely collected passive HA hospital discharge data are likely to underestimate the true disease burden of such conditions caused by specific viral pathogens in this population. This emphasises the importance of undertaking active surveillance to provide a more precise estimate of such disease burdens. Despite these limitations, the current CMS database of discharge information is an important resource that could be further enhanced by routinely linking all laboratory data with the discharge diagnosis information, so as to enable estimates of pathogen-specific disease burdens. Consideration could be given to establishing designated sentinel hospitals and alternative strategies to improve and standardise coding, eg writing discharge diagnoses in free text for subsequent standardised coding by trained clerks.

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APPENDIX. Coding details based on International Classification of Diseases (ICD9-CM)

Respiratory-associated hospitalisations*	ICD9-CM codes
Upper respiratory infections	460-461.9, 465-465.9, 786.2
Pharyngitis and tonsillitis	462-463.9, 034.0, 474.11
Croup and laryngitis	464-464.9, 786.1
Otitis media	381-382.9
Bronchitis and non-specific chest infection	466-466.09, 490-490.9, 519.8
Bronchiolitis	466.1-466.9
Bronchiolitis due to respiratory syncytial virus (RSV) infection	466.11
Pneumonia	480-486.9, 507.0
Influenza	487-487.9
Asthma and allergic rhinitis	493-493.9, 477-477.9

* **Classification into these groups was done at two levels: (1) primary diagnosis only; and (2) any of 15 possible diagnostic codes listed in the Clinical Management System, as a number of admissions had more than one respiratory ICD9-CM code, this further classification was undertaken in a hierarchical fashion with the second code taking precedence over the third and so on**

Further classification was made for the following specific diseases, listing the number of patients that had any of the 15 diagnoses as:

Respiratory-associated hospitalisations	ICD9-CM codes
Bronchiolitis	466.1-466.9
RSV bronchiolitis	466.11
RSV infection	466.11, 480.1, 079.6
Influenza	487-487.9
Parainfluenza	480.2
Adenovirus	480.0, 079.0