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Proceedings of Paediatric SARS

Paediatric SARS Seminar held on 20 April 2003 at the Hospital Authority, being organised by the Hong Kong College of Paediatricians and Princess Margaret Hospital (PMH)

The Princess Margaret Hospital Paediatric SARS Experience

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From 29 March 2003, Princess Margaret Hospital (PMH) being designated as the only SARS hospital, had to admit all SARS patients of Hong Kong, and the Department of Paediatrics & Adolescent Medicine was responsible for managing all suspected SARS/SARS patients below 18 years of age. This lasted for 10 days, during which a total of 110 patients below 18 were admitted. Afterwards, PMH continued to manage such patients with other hospitals together.

Preparation of the Mission

Wards

It came with a very short notice. Within 48 hours we had to start admitting all SARS children and adolescents. On the one hand, more than a hundred patients, including NICU, SCBU, PICU and long term ventilator care patients had to be transferred to other hospitals or discharged, while on the other hand, we had to prepare wards to admit SARS patients.

At the beginning, it was not easy to estimate the number of beds required. But since the infection had spread to the community, there wasn't good reason to presume children would be exempted from being infected. From Census 2002, 19.9% of the total population are below 18 years of age. Thus, the number of beds required might constitute 20% of the total beds as an estimate.

In the initial phase, 5 wards of 108 beds were opened, one ward for PICU/NICU, one for SARS children below 8 years old, one for 8-17 years old SARS boys, one for 8-17 years old SARS girls, and one for suspected SARS patients. The guiding principles in the preparation were that these wards should abide to infection control recommendations in that they had to be spacious, and the bed number in each ward had to be kept to a minimum, and that there should be adequate staffing ratio especially in PICU. Staff safety was the number one concern in the whole exercise.

Staff

Doctors and nurses of the Department were called for in fighting the battle, and were trained in infection control in protecting themselves. Medical staff was divided into 2 teams, a SARS team and a non-SARS team taking care of general/renal/SOPD duties. The two teams were totally separated in duties including on-call. Such measure was to minimize the risk of cross infection. For the SARS team, there were altogether 16 medical officers led by 5 consultants and 6 senior medical officers; and for the non-SARS team, 8 medical officers were led by 1 consultant and 2 senior medical officers. It was fortunate that there a few volunteers joining the Department to strengthen our force to fight the battle.

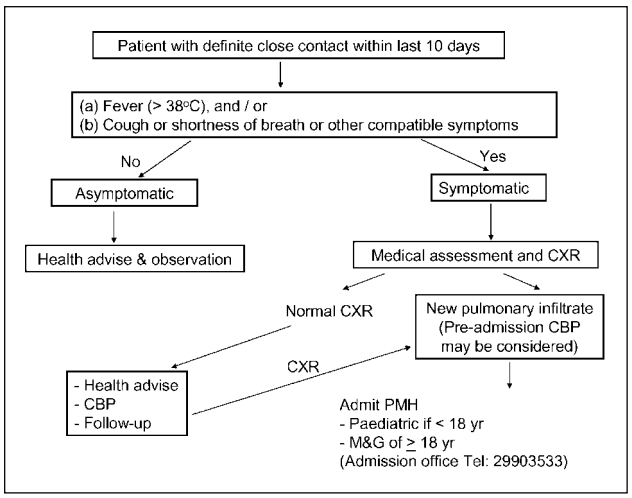

Figure 1 A&E management flowchart (for definite contact).

The Exercise

Patients were admitted according to the guidelines drawn up for all accident & emergency departments, which were applicable for both adults and children (Figures 1 & 2).

From 29/3 to 16/4, there were altogether 745 admissions for the whole hospital, of which 133 were below 18 years old (17.9%). The ratio of Medical: Paediatric admissions was 4.6:1. Most admissions occurred in the first 10 days which cumulated to 123 at 12.3 per day (Figure 3). The % of admission according to age groups quite correlated with the % population at a slightly lower percentage (Table 1). Clinical SARS was diagnosed according to the criteria of fever, Chest X-ray of pneumonia/acute respiratory distress syndrome, close contact, failure to respond to antibiotics, and relevant symptoms (Table 2). Following those criteria, 43 patients were diagnosed as clinical SARS, with 74.4% of 10-17 years of age among the group below 18 (Table 3). The treatment regimen was also standardised using ribavirin, prednisolone and pulse methylprednisolone with a stepwise approach according to severity and clinical response. As no visiting policy had to be strictly adhered to, there were psychosocial issues for patients staying in hospital. Informing parents at fixed time each day helped communicate medical conditions to alleviate anxieties and worries of parents.

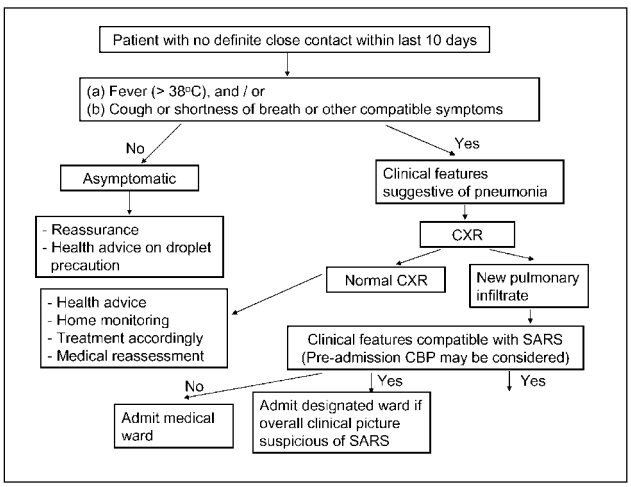

Figure 2 A&E management flowchart (for no definite contact).

Results

Patients

Of the 43 clinical SARS patients, 5 required PICU care having 2 put on BiPAP and 1 intubated. By 19/4, there was

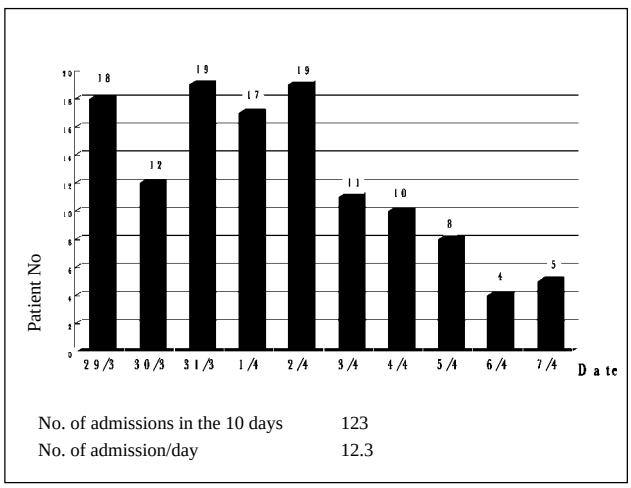

Figure 3 Paediatric admissions 29/3-7/4.

no mortality. In addition there were 3 babies born from SARS mothers. All were premature babies having Caesarean section deliveries at 28, 26, 32 weeks gestation, and requiring NICU care. Eighty-three patients had been discharged, including 13 SARS and 70 non-SARs by 19/4.

Table 1 Admission according to age groups

Age (yr)	No.	% admission	% population*
0-4*	33	4.4	4.0
5-9	39	5.2	5.8
10-14	39	5.2	6.4
15-17	22	3.0	3.8
Total	133	17.8	20.0

*3 premature babies born from SARS mothers

Table 2 Clinical SARS in children and adolescent

Age	SARS		Paed. admissions	
(yr)	No.	%	No.	%
0-4	3	7.0	33	24.8
5-9	8	18.6	39	29.3
10-14	19	44.2	39	29.3
15-17	13	30.2	22	16.6
Total	43	100	133	100

No. of clinical/confirmed SARS: 43

No. of babies born from SARS mothers: 3

Table 3 Results-patients outcome

Patients: (Till 19/4)	
No. of clinical SARS	43
No. of babies from SARS mothers	3
No. of patients requiring PICU care	6
requiring intubation	(1)
requiring BiPaP	(2)
No. of patients requiring NICU care	3
No. of death	0

Staff

There were no medical staff nor supporting staff infected, however 2 nurses came down with the disease. They probably had contracted the disease during at the start of the exercise when a large number of SARS patients were admitted. The infection rate was much lower compared than the adult counterpart especially with ICU. This might be related to fewer critical cases, lower infectivity in children and fewer patients we had compared with adults.

Follow on Actions

SARS patients need to be followed up for any sequelae, such as pulmonary function dysfunction. Psycho-social problems had to be looked into especially for those families who had parents who died of the infection. Special features of SARS in children were to be identified. Non-SARS patients were also followed up for any missing cases, studying infectivity.

Summary

The whole exercise was a very special and unusual experience. Having to evacuate patients within a short period of time to admit a highly infectious disease was an unprecedented move in the medical history in Hong Kong. There were many lessons learnt from the exercise, which included risk management in fighting a highly infectious disease. Good planning and preparation are important, and training in infection control essential for staff. Full protection in ICU is important and staff performing high risk procedure like intubation need to be well protected. To have a separate SARS team of staff helped minimise the risk of cross-infection. Though universal precautions need to be established in all areas, it is considered important to protect high-risk patients including those immunocomprimised, debilitated patients and pregnant mothers from the infection.

Clinical Features, Diagnosis, Treatment and Short-term Outcome of Severe Acute Respiratory Syndrome (SARS) in Children

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Clinical Features

Symptoms and signs caused by coronavirus-associated atypical pneumonia (or SARS) are non-specific. In adult patients, the commonest presenting clinical features are fever, malaise, chills, rigor, myalgia, headache, dizziness and cough. In children, especially young children and infants in which fever is generally present, the other systemic and respiratory symptoms may not be prominent or are difficult to elicit.

In a series of 43 children aged less than 18 years who were treated at the Princess Margaret Hospital (PMH) in March to April 2003, the following presenting clinical features in percentages are noted (Table 1).

In general, the older the children, the more pronounced are the systemic symptoms like high fever, malaise, chills, rigor, headache and myalgia. Respiratory symptoms like cough, coryza, sore throat, sputum production and dyspnoea are often absent although the disease primarily involve the lungs. Initial symptoms in infants and young children may be deceptively mild but they do not necessarily run a mild clinical course. A period of close observation following the onset of fever usually will clarify the picture and lead to a more definitive diagnosis.

Table 1 Presenting clinical features in 43 children aged less than 18 years with clinical diagnosis of SARS (information only accurate up to 20 April 2003)

	% (N=43)
Fever	100
Cough	65
Malaise	58
Sputum production (Phlegm)	42
Coryza	40
Myalgia	37
Headache	35
Chills and/or rigor	33
Nausea and/or vomiting	28
Sore throat	16
Diarrhoea	16
Dizziness	12
Dyspnoea	9
Anorexia	7
Abdominal pain	7
Lethargy	7
Chest pain	2

As the presenting clinical features are non-specific, even in adults, additional clues like a contact history, abnormal chest radiograph and sometimes characteristic though not pathognomonic, initial laboratory findings are extremely helpful in clinching a diagnosis. Suggestive laboratory abnormalities include one or more of the following: decreased white cell and lymphocyte counts, decreased platelet count, elevated liver enzymes, creatine kinase and lactate dehydrogenase levels. This underscores the importance of a good history taking, appropriate investigations and a period of close clinical observation in the diagnostic process.

Diagnosis

Four aspects of diagnosis are essential in the overall work-up of a suspected case of SARS.

1. Clinical

The presenting clinical features plus symptoms and signs that evolve as the illness progresses will usually clarify the picture and lead to a better differential diagnosis. The list of differential diagnoses to consider includes community acquired pneumonia caused by bacteria, viruses, mycoplasma and chlamydia. Common respiratory viruses that can cause pneumonia include influenza A and B, parainfluenza types 1, 2, and 3, respiratory syncytial virus (RSV) and adenovirus. Pneumonia caused by the novel coronavirus (SARS-CoV) is a new clinical entity which does not have a pathognomonic feature. That makes its diagnosis often difficult especially during seasonal epidemics of other respiratory viruses like influenza, RSV and adenovirus. Laboratory investigations are always indicated to exclude the diagnosis of bacterial, other viral, mycoplasmal and chlamydial pneumonias.

In the absence of an epidemic or outbreak situation, the diagnosis of coronavirus-associated atypical pneumonia (or SARS) is often by an educated exclusion of other causes of pneumonia.

2. Epidemiological

In a series of 43 children diagnosed and treated at PMH in March to April 2003, more than 80% of patients have a definite contact history (Table 2).

The importance of meticulously eliciting a contact history in helping the diagnostic process cannot be overemphasised as children are usually the victim of an infectious disease, as in this case, instead of the source of infection.

3. Radiological

A chest radiograph (CXR) is an indispensable investigation and very often the CXR needs to be repeated as frequently as the change in clinical condition warrants. However, no characteristic radiographic findings exist for SARS. The appearances of focal or diffuse consolidations are not unique and many other causes of atypical pneumonia can produce the same picture. Nevertheless, if a contact history is forthcoming, the suspicion will certainly be heightened. Increased vigilance for the possibility of SARS is the key to radiological diagnosis. If the condition is not suspected, the diagnosis will never be made.

When the diagnosis of SARS is highly suspicious, based on clinical features and an epidemiologic link, and yet the CXR findings are not definite (e.g. early in the course of illness or pneumonic infiltrates are obscured by the cardiac silhoutte), a computed tomography (CT) of the chest will be of immense help.

Again, the CT findings of SARS are non-specific and cannot pin-point the exact aetiology or the infectious agent. However, in the presence of a contact history and additional suggestive laboratory findings, the utility of CT when suggestive CXR findings are lacking cannot be underestimated.

Table 2 Sources of contact in 43 children aged less than 18 years with clinical diagnosis of SARS (information only accurate up to 20 April 2003)

	No. (N=43)	%
Amoy Gardens point source outbreak	27	63
Hospital contact	4	9
Social contact	3	7
Household contact	2	5
Unknown	7	16

4. Microbiological

The purpose of microbiological investigations is three-fold – exclusion of common pathogens causing community acquired pneumonia (e.g. *Streptococcus pneumoniae*), exclusion of less common pathogens causing atypical pneumonia (e.g. influenza virus), and confirmation of SARS through identification of SARS-CoV using reverse transcriptase polymerase chain reaction (RT-PCR) for viral genetic material (RNA), paired serology for antibody response and viral culture for isolation of the live virus.

RT-PCR is a rapid diagnostic tool which complements clinical and radiological diagnosis. However, the first generation RT-PCR assay is far from perfection in terms of sensitivity although it has high specificity.

In the PMH series, the sensitivity of the test in diagnosing SARS was only 50% when nasopharyngeal secretions were used as specimens. Use of stool specimens for the test may improve the sensitivity and should be done together with respiratory specimens. A negative RT-PCR result may not mean the absence of disease (false negativity). Hence the test cannot be used for excluding the diagnosis of SARS or for decision making in early discharge of patients suspected of suffering from SARS.

An increase in specific antibody titre against the SARS-CoV in the convalescent serum of a patient with a suspected diagnosis of SARS essentially confirms the diagnosis. However, rise in antibody titre is delayed and may not be evident for as long as 3-4 weeks after the onset of fever. Hence, serological diagnosis is in general retrospective and often cannot benefit treatment decision.

Likewise, recovery of the live virus by viral culture of respiratory secretions or stool is time consuming and labour intensive. Although it is the gold standard of diagnosis in virology, the utility of the test in SARS is undermined by the apparent difficulty in growing the virus in special cell lines or tissue culture media using sophisticated technique in advanced laboratories. Again, diagnosis made by viral culture is in general retrospective, appears to be less sensitive, and often will not help management decision in the acute phase of illness when patients are in dire need of prompt diagnosis to target treatment.

The diagnostic approach to SARS in children will only improve with accumulated clinical experience and the development of very sensitive and specific rapid diagnostic tools, which is the prime focus of ongoing intense research.

Treatment

No specific therapy was available when SARS first appeared in medical history and the aetiological agent was not even known. The need for coverage of a suspected viral cause had led to inclusion of the most broad-spectrum antiviral agent available then on the market, ribavirin, in the initial treatment regimen. Subsequently, it was perceived that the pathogenesis of the atypical pneumonia had a strong immunologic component, and then corticosteroid was also included in the treatment protocol to suppress the overactive immune response, with well documented success. Very soon, a cocktail comprising of oral or intravenous ribavirin, and various dose combinations of different corticosteroids (e.g. Prednisolone, hydrocortisone and methylprednisolone) has become standard therapy. The usual course of ribavirin treatment lasted for 1-2 weeks, and that of corticosteroid 2-4 weeks. However, as the epidemic unfolded, it was soon realized that some adult patients did not respond to the combination of ribavirin and steroid, or initially responded but later relapsed in the third week of illness. Novel therapy for salvage of these unfortunate adult patients who failed to respond to repeated doses of pulse methylprednisolone and suffered from uncontrolled immunologic destruction of their lung tissues became the prime focus of clinical research. Use of immunomodulating agents like Pentaglobin (IgM), intravenous immunoglobulin (IVIG), cyclophosphamide, thalidomide, anti-TNF-alpha (Infliximab) etc. emerged on the research agenda of investigative compounds. Similarly, other antiviral agents, including interferon-alpha, were considered in the face of growing evidence of lack of in vitro and clinical efficacy of ribavirin for the treatment of coronavirus infection. Agents like protease inhibitors (e.g. Kaletra, which is a combination of ritonavir and lopinavir, originally marketed for treatment of HIV infection) showed initial promise, and clinical efficacy was forthcoming when used in combination with ribavirin in situations where repeated high doses of methylprednisolone had clearly failed. The use of neutralising antibody contained in the plasma of convalescent patients with laboratory confirmed SARS was also attempted with encouraging results in terms of immediate mortality and discharge at 22 days from onset of fever, provided that the convalescent patient plasma was administered before 16 days from onset of fever.

All in all, new modalities of treatment, both antiviral and immunomodulating, have become the focus of ongoing intense research to unravel the therapeutic futility faced by clinicians in their fight against SARS. For survivors of SARS who required mechanical ventilation or have significant pulmonary complications, long-term follow-up of their lung functions is indicated (e.g. for monitoring of pulmonary fibrosis). Of course, prevention is always the best cure. A vaccine that induces both individual and herd immunity will be the ultimate answer to conquering the dreadful coronavirus, which is emerging as a pandemic global threat to human existence.

Last but not least, children who are hospitalised with SARS may require prompt professional psychosocial intervention during their prolonged stay in hospital with a life-threatening ailment and treatment with drugs that may cause psychological adverse effects, and especially when one or both of their parents have died from SARS. Clinical psychologists can better explain the role of psychological support and management in children with SARS.

Outcome

In our experience, children with SARS will recover with good supportive care and specific drug treatment, although adolescents and very young infants may be at risk of severe illness and may require intensive care. A simplified summary of the treatment and outcome of 43 children hospitalised at Princess Margaret Hospital in March-April 2003 is presented in Table 3.

Table 3 Treatment and outcome of 43 children with SARS hospitalised at PMH in March-April 2003 (information only accurate up to 20 April 2003)

	No. (N=43)	**%**
Death	0	0
Oxygen therapy	8	19
- CPAP via nasal prong	1	2
- noninvasive ventilation (BiPAP)	1	2
- intubation and mechanical ventilation	1	2
- nasal cannula only	6	14
Pulse methylprednisolone therapy	10	23
Intensive care	5	12

Neonatal Aspect of SARS

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Introduction

Since the outbreak of the Severe Acute Respiratory Syndrome (SARS), more than 1700 people were infected in Hong Kong. During the height of the epidemic in early April, three infected pregnant women delivered their preterm babies by Caesarean section in Princess Margaret Hospital because of deteriorating maternal condition. In the Seminar of Paediatric SARS held in 20th April 2003, the early clinical courses of the world's first three neonates of mothers with SARS were reported and the infection control measures for the delivery and caring of these newborns were also discussed. The following is a brief account of the discussion.

Brief Summary of the Clinical Courses of the Three Neonates

Three premature neonates were delivered by Caesarean section from 3 pregnant women with SARS in April 2003.[1] The maturity and the birth weight of these neonates ranged from 26 to 32 weeks and 975 to 1650 gram respectively. All three mothers had received treatment with Ribavirin and Corticosteroid and required mechanical ventilation at the time of delivery. These neonates did not show any feature of SARS after birth. The laboratory investigations and the reverse transcription polymerase chain reaction (RT-PCR) studies for SARS-CoV infection were all negative up to the second week of life. Two of these neonates developed illness of the intestine with one got necrotising enterocolitis affecting the ileum on day 10 of life and the other one had isolated perforation of jejunum on day 3 of life. The definite cause of these complications was still undetermined.

Infection Control Measures for the Delivery and Caring of Newborns of SARS Mothers

As the secretions and body fluid of the infected mothers would be very contiguous and it cannot be certain whether the newborns have been infected in utero or not, the infection control measures should be aimed at protecting the staff as well as the newborns from being infected by the mothers.

The infection control measures include several aspects:

1. Venue

a. The delivery and resuscitation of the newborns should be conducted in facilities equipped with negative pressure ventilation system to prevent the spreading of the virus as the procedures would involve handling of large amount of body fluid such as amniotic fluid and blood. Also artificial ventilation of the mothers and the babies would generate significant amount of aerosol of the respiratory secretion which is very infectious. Ordinary operating theatre having positive pressure ventilation design should never be used.
b. The newborn resuscitation should be carried out in a room near but separated from the maternal room. This will minimise the exposure of the newborns and the staff to the maternal secretion after delivery thus decreasing the chance of acquiring the virus from the mothers.

2. Personal Protective Equipment

a. All personnel involved should wear proper protective equipment including caps, goggles, waterproof disposable growns, shoes covers, gloves and masks.
b. As aerosol of the body fluid may be generated during the delivery and resuscitation, the minimum requirement for masks must be N95. Use of masks with higher degree of protection such as Powered Air Purifying Respirator (PAPR) is preferable. If PAPR is used, the staff should also wear a N95 mask within the PAPR to prevent the passage of unfiltered exhalation gas of the staff to the environment.
c. If the team performing newborn resuscitation needs to transport the newborns to the nursery, the team must ensure that proper protective gears should also be used during the transportation while the protective clothing contaminated during the delivery or resuscitation should be removed before stepping out of the venue to prevent environmental contamination. If time is not allowed for proper changing of protective gears, wearing 2 layers of each item of protective gears initially may help to reduce the time needed. The team can remove the outer layer of protective gears after the delivery and resuscitation while keeping the inner layer for the transportation of the newborns.

3. Equipment

a. Suction equipment
   i) Wall vacuum rather than the built-in electric pump of the radiant warmer or simple bulb syringe should be used for suction, as the gas sucked in will be expelled to the environment in the latter two methods.
   ii) Viral/bacterial filter should be connected to the suction unit before entering the wall suction port to prevent contamination of the hospital suction plant (Figure 1).
   iii) Closed suction system that can prevent disconnection of the tubing during suction should be used once the patient was intubated.

b. Resuscitation bag
   i) Viral/bacterial filter (Hygrobaby) should be connected between the resuscitation mask/ endotracheal tube and the resuscitation bag to capture the exhaled virus.
   ii) Use of bag and mask ventilation should be minimised, as leaking of gas through the mask is inevitable. Early intubation should be considered if needed.
   iii) Connect the patient to a modified ventilator once intubated to minimize using of the resuscitation bag. The ventilator should be set by the side of the radiant warmer for use during resuscitation.

c. Ventilator
   i) Gas from the expiratory limb of the circuit should pass through a viral filter before returning to the ventilator (Figure 2).
   ii) Exhalation gas from the ventilator should be diverted away from the ward atmosphere by the use of scavenger system.
   iii) Scavenger system of infant star ventilator can be made by applying wall suction to the exhalation port through a T tube or a similar adaptor (Figure 2).
   iv) The ventilator of the transport incubator should also have a viral filter connected to the expiratory limb (Figure 3).

4. Isolation

a. The newborns should be separated from their mothers and nursed in an isolation room.
b. Keeping the babies inside the incubators can help to reduce the spreading of the virus from the babies.
c. A mini negative pressure chamber can be created by applying wall suction to a headbox covering the head and shoulder of the baby (Figure 4). If the baby is too vigorous for the headbox, putting the suction catheter inside the incubator with maximum suction force applied would also help to reduce the aerosol from going out of the incubator.

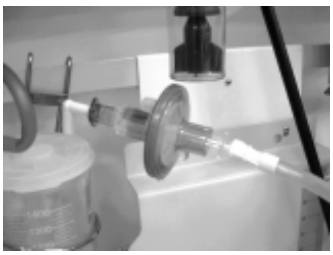

Figure 1.

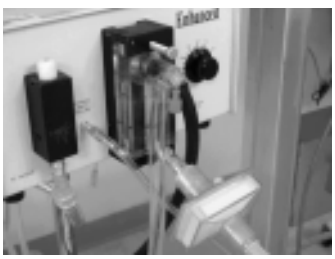

Figure 2.

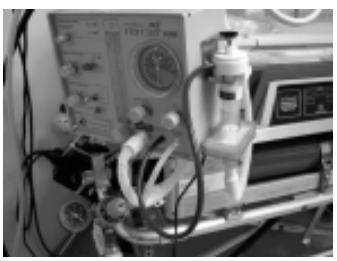

Figure 3.

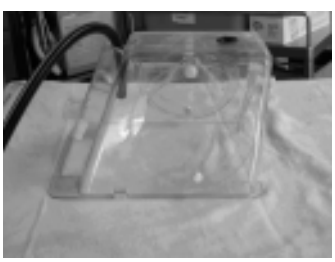

Figure 4.

5. Mode of Delivery

The delivery should be conducted in a well-controlled manner to ensure better infection control. Therefore, for non-emergency cases, delivery by elective Caesarean section at near term is preferred to allowing vaginal delivery after onset of labour. The risk of vaginal delivery may be higher in the following aspects,

a. The first and second stage of the labour may last for hours, therefore the staff attending the delivery will have a longer exposure to patient's secretions.
b. The struggling of the mother during the labour will cause shedding of secretion and thus the virus.
c. Mothers with poor respiratory reserve would have poor effort during labour. This may lead to the use of instrumental delivery. The use of vacuum extraction may induce wound over scalp of the newborns and so increase the chance of infection.
d. Emergency delivery by Caesarean section may be needed during the first and second stage of the labour such as in cases of cord prolapse and foetal distress. There may not be sufficient time to prepare and put on the protective clothing.
e. The chance of having meconium stained liquor is higher when the pregnancy is full term or even post term. The procedure of clearing the meconium from the trachea of the newborns by repeated intubation and suction would impose a great risk to the staff.

Conclusion

The neonatal section of the Seminar of Paediatric SARS served the purpose of sharing the experience of the Princess Margaret Hospital in the management of newborns of mothers with SARS. The importance of infection control in the delivery suite and the neonatal intensive care unit has also been raised.

Reference

1. Shek CC, Ng PC, Fung PG, et al. Infants born to mothers with Severe Acute Respiratory Syndrome (SARS). Pediatrics (unpublished).

Infection Control and Staff Protection

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The virus causing SARS is identified to be Coronavirus. It is detected in respiratory tract secretion, urine and stool. It should be stressed that standard droplet and contact precautions should be strictly enforced. From the up to date information of epidemiological study, the mode of transmission is by droplets and direct contact with patient's secretions and subsequent inoculation into mucous membranes e.g. oral mucosa, conjunctiva etc.

We should practice infection control precautions in all healthcare settings. All staffs (including working in ancillary areas) working in healthcare settings should receive proper infection control training. The staffs should be informed the latest guidelines in infection control and there should be an enforcement group in hospital to reinforce the infection control policy among the front line staffs.

Negative Pressure Room

SARS patients should preferably be nursed individually in rooms with negative pressure, the contaminated air will be drawn outside to the environment and not recirculate into the ward. The air exchange in these rooms should be up to at least 12 exchanges per hour. These can markedly decrease the viral load present in the nursing environment and the chance of staff getting infected.

If the negative pressure rooms is not available. The isolation rooms should be well ventilated with adequate fresh air exchange. Consultation with and advices from aerodynamic and architectural specialists is useful.

Environmental Control and Decontamination

There should be a good environmental control. The ward environment should be divided into Dirty Zone (the viral load is high) and Clean Zone (it should be a clean area, the viral load should be zero). Inside the Dirty Zone is where the patient was nursed whereas the Clean Zone is the changing and resting area for staffs.

Dirty Zone – Inside where all staffs are in full protective gear.

All clinical areas should be disinfected by hypochlorite 1000 ppm frequently e.g. ward environment, facilities and equipments (regularly and after used). These include all horizontal surfaces (e.g. over-bed table, night stand), surfaces that are frequently touched by patients and healthcare personnel (e.g., door knobs, bed rails, public phone), and lavatory facilities.

Avoiding sharing of equipment/devices (stethoscope, scissors, bedpan, etc.) between patients, if sharing cannot be avoided. These should be disinfected in between patient use. Disinfectants should be widely available at appropriate concentrations.

There should be proper procedures in waste disposal, handling of dirt linen and soiled gowns. Staffs performing cleansing and laundry should wear appropriate Personal Protective Equipment and these should readily available for them.

Staff Safety and Protective Gears

Infection Control measures for staffs should include: **Standard precautions** (e.g. hand hygiene); **Contact precautions** (e.g. use of gown and gloves for contact with the patient or their environment) and **Airborne precautions** (e.g. an isolation room with negative pressure relative to the surrounding area and use of an N-95 filtering disposable respirator for persons entering the room).

Staff wearing full protective gear.

Staffs should be trained the correct procedures when entering or leaving a dirty zone. They should have full barrier precaution including N95 particulate respirator or mask, goggles/eye shields, head cover, protective gowns. The use of gowns with different degree of water permeability depends on different medical or nursing procedures.

The use of "Barrierman" or "Shoe covers" is controversial, the perceived benefit must be balanced against the users compliance to correct usage.

Procedures When Entering and Leaving a SARS Ward (Dirty Zone)

On **ENTERING**:

1. Put on a mask
2. Put on protective eyewear (especially if there is close patient contact)
3. Put on a cap
4. Put on a gown
5. Rub hands with alcoholic handrub and allow to dry
6. Put on gloves
7. Enter the ward/ICU

On **LEAVING**

1. Remove gloves (dispose into waste bag)
2. Remove gown (dispose into waste bag)
3. Must wash hands
4. Remove cap (dispose into waste bag)
5. Remove protective eyewear, clean with 70% alcohol and store in labeled paper bag
6. Remove mask; discard if contaminated, or store in labeled paper bag for reuse
7. Rub hands with alcoholic hand rub and allow to dry (if hands soiled, must wash hands before leaving the ward)
8. Put on a surgical mask whilst outside high-risk area.

Particulate Respirator Mask

A particulate respirator is designed to provide respiratory protection for the wearer. It provides an effective barrier to prevent healthcare workers from inhaling airborne pathogens such as Mycobacterium tuberculosis. The level of protection is determined by the efficiency of the filter material and how well the face piece fits or seals to the health care worker's face. N95/N100 means filter efficiency level of 95%/99.75% against particulate aerosols free of

oil respectively. N95/N100 masks (non-valve or valved) comes in different models e.g. SH 2950, 8210, 1860, 9210, 9211 and 8233 etc. A Half face respirator with P-100 filter can be used when staff fails the fit test in all the available models of N-95 respirators supplied by the hospital.

All respirators that rely on a mask-to-face seal need to be annually checked with either qualitative or quantitative methods to determine whether the mask provides an acceptable fit to a wearer.

The particulate filter should be changed if breathing become difficult or respirator becomes damaged or distorted or a proper face fit cannot be maintained.

N95 mask comes in different models to fit different face contour.

How to Test Fit a Particulate Filter (Fit Check)?

A fit check should be performed every time the respirator is put on. Cup both hands over the respirator and exhale sharply, if air leak from the nose, the user should adjust the nosepiece. If air leak from the edges, reposition the headband can achieve a better fit.

A Qualitative Fit Test

The qualitative fit test procedures rely on a subjective sensation (taste, irritation, smell) of the respirator wearer to a particular test agent e.g. Isoamyl Acetate, Saccharin Solution Aerosol, Bitrex™ (Denatonium Benzoate) Solution Aerosol. The most convenience is the Saccharin Solution Aerosol.

Staff performing Fit Test using the Saccharin solution aerosols method.

Higher Level of Respiratory Protection

A higher level of respiratory protection may be required for staffs working during aerosol-generating procedures on SARS patients. It include: Powered air purifying respirator (PAPRs) designed with loose-fitting facepieces that form a partial seal with the face; PAPRs with hoods that completely cover the head and neck and may also cover portions of the shoulder and torso.

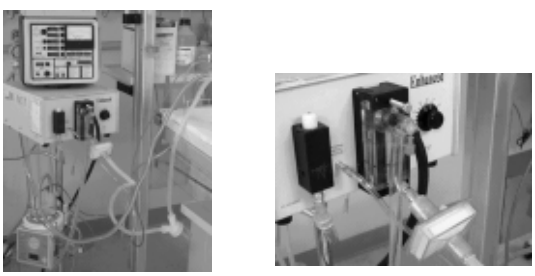
The use of these devices requires training and practice and they are difficult to disinfect. The user must strictly follow the guideline before its use.

High efficiency Powered Air Purifying Respirator (PAPRs).

High Risk Procedures

Staffs performing certain high risks procedures may have an increased risk of contracting SARS. These procedures capable of stimulating cough and promoting the generation of aerosols include: nasopharyngeal aspiration, administration of aerosolized/nebulized medication; diagnostic sputum induction; bronchoscopy; airway suctioning; endotracheal intubation; positive pressure ventilation via facemask (e.g. BiPAP, CPAP), during which air may be forced out around the facemask; and high frequency oscillatory ventilation (HFOV).

These high risks procedures should be performed in rooms with negative pressure and all staffs should be reminded to wear full barrier precaution.



Attachment of a high quality bacterial filter to the expiratory port of the ventilator.

Restricted Access to SARS Areas

There should be no visiting policy for SARS ward. In exceptional circumstances whereas visiting is allowed, the visitors should be educated to take full barrier precaution when visiting SARS patients and they should be responsible for their own health.

No visitor policy.

Personal Health and Hygiene

All staffs should have their own temperature measured before going to work. They should report fever and symptoms to their supervisors to prevent cross-infection among workers in case they contracted SARS.

Staff measuring tympanic temperature before duty.

Careful hand hygiene is urged. Staffs are also reminded of the importance of hand washing (hand anti-septic e.g. Hibiscrub, especially after removing face mask and gowns and handling patients) and the strict avoidance of touching or scratching of eyes, nose and mouth with hands. Non-alcoholic handrub may be a substitute if there is no obvious organic material contamination and immediate handwashing is not available.

Signs reminding and re-enforce staffs handwashing.

Personal belonging must protected against contamination with viruses e.g. put in a plastic bag and discarded when leaving the dirty zone.

Avoid bringing personal stationary into the dirty zone. Tray with shared stationary, which will stay in the dirty zone.

Staff should minimise their social activities. They should keep adequate distance during social contact e.g. having lunch and gathering, preferably wearing a surgical mask.

Infection Control Related Links

1. Paediatric SARS Group (HK)
   Discussion Forum for Specialist Paediatricians on SARS
   http://www.paedsarshk.org
2. World Health Organization - Section on SARS
   http://www.who.int/csr/sars/infectioncontrol/en/
3. Centre of Disease Control and Prevention
   http://www.cdc.gov/ncidod/sars/ic.htm
4. Centre of Disease Control and Prevention
   Information on hand hygiene
   www.cdc.gov/handhygiene
5. Procedures in performing a Qualitative Fit Check
   http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9780&p_text_version=FALSE
   http://www.osha.gov/SLTC/etools/respiratory/oshafiles/fittesting1.html
6. Health Canada: SARS information for professionals
   http://www.hc-sc.gc.ca/pphb-dgspsp/sars-sras/prof_e.html
7. Paediatric Approach to SARS - Hospital for Sick Children, Toronto, Canada
   http://www.sickkids.on.ca/HealthCareProfessionals/custom/paeds_sars.asp?s=Paediatric+Approach+to+SARS&sID=5139
8. Ministry of Health, Singapore - SARS update
   http://app.moh.gov.sg/sar/sar01.asp
9. Taiwan Center for Disease Control - SARS information page
   http://www.cdc.gov.tw/atyp/en/
10. Ministry of Health, Malaysia - SARS information page
    http://webjka.dph.gov.my/sars/
11. Ministry of Health, People Republic of China (Chinese GB code webpage)
    http://www.moh.gov.cn/
12. Beijing Center for Disease Control, PRC (Chinese GB code webpage)
    http://www.bjcdc.org/jkzl/zwfd.asp
13. Chinese Centre for Disease Control and Prevention (Chinese GB code webpage)
    http://www.chinacdc.net.cn/