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POINTS OF CONTROVERSY IN PAEDIATRIC INFECTIOUS DISEASE

**Viral infections in children's wards—how well do we manage them?**

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**Summary:** Children are frequently admitted to hospital wards with viral infections. Many are not life-threatening to the index case, but the spread to vulnerable patients who are already at higher risk should be avoided. To do so requires active awareness and availability of rapid diagnosis (i.e. the same day). Cohorting and handwashing have been found to be the best measures to prevent spread of respiratory syncytial virus (responsible for considerable morbidity every winter) in hospital wards.

*Keywords:* Viruses; cross-infection; children's wards.

**Introduction**

The brief answer to the question in the title is: 'Not particularly well', but that answer also fails to understand the nature of the problem. As so often, the answer to a simple question is complex, and is a mixture of three factors: our general attitude to viruses; a lack of data on the size of the problem; and an uncertainty how to tackle a problem whose size is unknown. This paper poses the questions, but getting the answers depends on the size of the resources; (a) to define the problem more clearly; and (b) to remedy any deficiencies in our management.

**Defining the problem**

No one would wish to have a virus infection themselves nor would they want the progress of any child in their care to be impeded by such an infection. Nevertheless hospital staff generally take a relaxed attitude to the possibility of infection—let us examine why this is.

*Attitudes to viruses*

If all virus infections were similar to the now defunct smallpox, this paper would not be needed. Smallpox was a serious life-threatening disease with

major, visible lesions on exposed parts of the body. In unprotected children the seriousness of the situation was obvious and the need to prevent spread self-evident. Change the disease to measles and a note of ambivalence is introduced at once.

Measles is not perceived as being so severe, though those who have seen complications, particularly in the immunocompromised but also in the immunocompetent, will not regard this as a trivial illness. Others will not be so concerned. Change the disease to another more banal such as minor respiratory or gastrointestinal disease and the level of anxiety drops still further.

Nevertheless, such infections can be severe and/or prolonged in immunodeficient children and can threaten the life of those with congenital defects. For these, infection with even common viruses should be avoided.

Part of the difficulty is that trivial infections by 'a virus' are part of normal life. Getting a cold is common and usually accepted with resignation. Unless we have a special reason to take them seriously we generally don't; they are just an uncomfortable component of our daily existence. Indeed we rarely bother to get them diagnosed—what's the point?; the argument goes, you can't do anything about them. We can, did and should take smallpox seriously. HIV, hepatitis B and C viruses, and lassa fever virus always cause concern no matter who the patient is, but with other viruses concern is related to the vulnerability of contacts.

#### *The size of the problem*

An explosive outbreak will attract everyone's attention and will probably be investigated. There are few data about endemic spread particularly in hospital. The same viruses may be involved in both kinds of spread though we know more about epidemics/outbreaks than what is routinely present. There is no doubt that outbreaks can occur,<sup>1-6</sup> but endemic spread may occur within wards. The virus(es) may also be introduced and re-introduced by staff and visitors, especially when it is widely present in the local community. The annual epidemic of respiratory syncytial virus (RSV) in most parts of the world illustrates this well.

RSV causes overt disease mostly in children under one year of age, but immunity to the virus is short-lived. Many older children and adults are re-infected and develop a minor upper respiratory disease rather than lower respiratory bronchiolitis. Every year in Newcastle upon Tyne about 550 babies are hospitalized with RSV bronchiolitis. An unknown, but probably far greater number of older children and adults are mildly re-infected and can transmit virus to susceptible infants. Interpreting whatever findings are obtained is not straightforward.

Tables I and II contain data from various wards in this hospital collected during the 1991/1992 and 1992/1993 annual epidemics of RSV. Twenty-one (9%) of the diagnoses were made more than five days after admission

Table I. *Respiratory syncytial virus isolations in the Royal Victoria Infirmary Newcastle, October–March 1991/1992 and 1992/1993 by ward*

Ward	Type of ward	Day of isolation post-admission						Total
		0	1	2	3	4	>5	
Children's day unit	Medical	32	0	0	0	0	0	32
Children's ward	Medical	22	50	13	5	3	8	101
	Medical	16	35	6	4	1	4	68
	Oncology	0	0	0	0	0	2	2
	Surgical	2	4	1	0	0	0	7
	Surgical	2	7	1	0	0	5	15
	Intensive care unit	8	2	2	1	0	1	14
Adult Ward	Oncology	1	0	1	0	0	0	2
	Dermatology	0	1	0	0	0	1	2
Total		85	99	24	10	4	21	243
(%)		35	41	10	4	2	9	100

Table II. *Day of isolation of 21 respiratory syncytial virus in relation to day of admission after day 4*

Day post-admission	5	6	7	9	11	12	14	15	16	>19	Total
No. of isolates	4	3	2	1	1	3	2	1	1	3	21

Table III. *Possible ways of preventing spread of viruses in the ward or hospital*

<i>Use of disinfectants</i>
Hypochlorite ('bleach')
Aldehydes: formaldehyde, glutaraldehyde
Detergents, soap
<i>Barrier-nursing</i>
Not as effective as expected
<i>Cubicalization</i>
British Paediatric Association recommends >50%
<i>Handwashing</i>
The best simple measure
<i>Cohorting</i>
Valuable in an epidemic
<i>Prevention by vaccines and/or antiviral drugs</i>
Mostly impractical
<i>Laminar flow canopies</i>
Expensive
For the most vulnerable only
<i>Close the ward</i>
Beware the virus' return on re-opening

(usually the limit of diagnosis in normal babies admitted with RSV) (Table I) and Table II shows the days post-admission when the diagnoses were made. These results could be interpreted as indicating that one baby in 11 is

infected in (and, by implication, from) the ward. However, it is equally possible that the longer they remained in hospital, the greater the chance that relatives or staff could transmit the infection through becoming infected themselves by a virus which was widely prevalent outside the hospital at the time.

Evidence for intra-ward spread could be found by detailed 'finger-printing' of the isolates (up to and including sequencing the viral genomes, if necessary) but was not done. It would have been time-consuming and therefore expensive and justifiable only if it led to action to prevent recurrence.

#### *What can be done?*

As has been shown in other contexts, the answer is almost anything provided the resources are available. The next section discusses some of the possible courses of action with their pros and cons.

### **Preventing spread**

Table III lists some possible ways of preventing spread by inhibiting virus release, removing it from the environment (ward) or shielding (vulnerable) recipients. Each will be discussed in turn.

#### *Use of disinfectants*

To be effective disinfectants have to be capable of damaging biological material. Viruses are not intrinsically different from the organic structure of the host and a totally 'safe' disinfectant which can be used indiscriminately is a mirage. Moreover, children may be damaged more easily than adults.

This is not to say that disinfectants are of no use, just that they have to be used with discretion and given time to act. Widespread washing-down of both horizontal and vertical surfaces can be done as a last resort. However, if it is done daily or even weekly it becomes expensive (cost of chemicals and time taken to spread them), inconvenient and generally unpleasant for everyone. Soap or detergent and water is probably just as effective through dilution if not inactivation, but is still time-consuming.

#### *Barrier-nursing*

This has been used extensively to prevent bacterial spread. The evidence that it is effective with viruses is more scanty and may work mainly by making all concerned more aware of the chances of cross-contamination. It certainly takes up a lot of staff time and barrier-nursing all children would be impractical. To confine it to those known to be infected would be to shut the stable door too late as is discussed below. It also needs to be combined with cubicalization which has its own drawbacks.

#### *Cubicalization*

This facilitates barrier-nursing and helps to reduce transmission (virus out) and receipt of virus (virus in), by putting physical barriers in the way.

Against this are the problems of supervising the patient, taking staff out of circulation, and psychologically isolating the children. The British Paediatric Association (BPA) has recommended that at least 50% of the total paediatric beds should be provided in cubicles.<sup>7</sup> Even 100% will not totally isolate individuals from relatives and other visitors who may carry viruses in from the community. Nevertheless the more extensive the cubicalization the smaller the risk of spread through the ward.

### *Handwashing*

Not all respiratory viruses are spread by droplets and there is evidence that RSV is spread via surfaces, and can be reduced by regular and thorough handwashing.<sup>8</sup> This is probably the most effective single measure to reduce spread and is reasonably cheap.

Routine washing between patients, however, is difficult to establish and maintain. Senior staff are notoriously liable to forget and viruses are no respectors of persons! For the nursing staff washing hands 20 or 30 times a day has penalties on skin, particularly if alcohol rubs are added and the use of emollient hand creams takes time.<sup>9</sup>

The main difficulty is keeping the regimen going for weeks and months, often in the absence of evidence of continuing cross-infection.

### *Cohorting*

This is the bringing together in a ward of all those admitted with, or acquiring, a particular virus. This can only work where rapid diagnosis is available and will be helped if staff are dedicated to the infected group and kept away from the non-infected.<sup>8</sup> There is evidence<sup>10</sup> that RSV spread can be halted by a gap of 6 ft between beds provided handwashing is routine.

### *Prevention by vaccines and/or antiviral drugs*

There are no vaccines or effective antiviral drugs for many common viruses. Even if there were, unless the vaccines were part of an eradication campaign there would be insufficient time to immunize the children before admission. Whether immunizing adults would prevent carriage would depend on both virus and vaccine but could not be assumed.

Routine prophylaxis with antivirals would be too expensive except, possibly, for some highly vulnerable children. Routine post-bone marrow transplant cover with acyclovir has reduced complications with cytomegalovirus<sup>11</sup> but this is very much a special case.

### *Laminar-flow canopies*

These overcome some of the objections of cubicalization but are very expensive. They can prevent infection of a few highly susceptible immunocompromised children for whom they have been shown to work well but they provide no routine solution.

Table IV. *Virus diagnosis: time taken using various techniques from receipt of the specimen in the laboratory*

Technique*	Time taken†	Specimen	Virus detected	Comment
Electron microscopy	30 min/2 h	Stool	Rotavirus, adenovirus, calicivirus, SRVs, SRSVs, etc	Relatively insensitive but detects all viruses present
		Vesicle fluid	Herpes simplex varicella zoster	
		Skin biopsy	Wart, molluscum contagiosum, orf	
Immuno-fluorescence	3 h	NPS/BAL	Common respiratory viruses	Not rhinoviruses, coronaviruses
		Skin/mucosal scrapings	Herpes simplex varicella zoster	
Enzyme immunoassays	3 h/ON	Biopsies	As appropriate	If antiserum available
Polyacrylamide gel electrophoresis	ON	Mostly as for IF	As for immunofluorescence	Less feedback on quality
Latex agglutination	20 min	Stool	Rotavirus, adenovirus‡	Very useful for contact tracing
				Commercial kits only. Not widely used and expensive on small numbers

Other techniques such as culture and serology take too long to be useful in limiting an outbreak.

\* Not all will be available in every laboratory—consult first.

† Shortest for one specimen/routine turnaround with specimen batching.

‡ Only in a few specialist laboratories.

NPS, nasopharyngeal secretions; BAL, bronchoalveolar lavage, ON, overnight.

### *Close the ward*

The ultimate sanction buys some time in the face of intractable cross-infection but is a policy of last resort because the infected babies or children have to be transferred to other wards and may simply enlarge the problem. Also the virus may recur on re-opening even if the ward has been completely redecorated. This suggests that the source may be human rather than being the environment. Screening staff may uncover a carrier but usually doesn't—the infecting dose may be smaller than that needed to make the diagnosis or excretion may be variable.

### **Virus diagnosis**

This is central to the problem. Many virus infections start with a 'flu-like' illness (mainly fever and malaise with no localizing features) and, without knowing the nature of the virus concerned, prevention will be based on guess-work. However, speed becomes important if any action to limit spread is to be taken. Table IV lists some of the techniques which can be

Table V. *Viruses causing most concern in children's wards*

Virus	Source of virus	Rapid diagnostic technique available	Specimen	Illness
Respiratory syncytial virus (RSV)	Other patients	Yes	Nasopharyngeal secretions	Bronchiolitis, failure to thrive, febrile fits, upper respiratory tract infection
Rotavirus	Other patients (staff?)	Yes	Stool	Diarrhoea (vomiting)
Hepatitis A virus	Other patients	No (antibody test)	Serum	Hepatitis, none
Enteroviruses, particularly echoviruses	Other patients	No (culture)	Stool; spinal fluid	Febrile illness, 'aseptic' meningitis, rashes
Herpes simplex virus	Staff	Yes	Vesicle fluid, ulcer scrapings	Stomatitis, cold sores, genital ulcers (rare in children)

used to diagnose virus infections, suitable specimens and the time taken. Not all will be in routine use in every diagnostic laboratory and Table IV is a guide to what can be done.<sup>12</sup> Contact the laboratory before problems arise to discuss how best to handle them.

To have any real chance of tailoring control measures to specific viruses, the diagnosis must be made within the same day, i.e. only electron microscopy, immunofluorescence, latex agglutination (if available for the virus) and some enzyme immunoassays are really suitable. Other tests will take longer and reduce the chances of being able to control spread of the virus except through general measures: isolation of the patient, rigorous handwashing, washing down of surfaces, etc.

Table V lists the viruses which cause concern more often, with a note of the availability of a rapid method of diagnosis and the most suitable specimen. From this it is clear that we lack at present a rapid method for diagnosing enteroviral infections. Whether the polymerase chain reaction can fill this gap is being explored in a number of laboratories but is unlikely to identify which virus is present—only that it is an enterovirus. However, this may be sufficient for starting control measures.

Nonetheless, viruses other than those in Table V may infect children (some are listed in Table VI) and those marked with an asterisk can be identified by same-day techniques. Several, such as influenza A and B, are woefully underdiagnosed in adults as well as in children.



Table VI. *Other viruses commonly infecting children admitted to hospital*


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Influenza A*
Influenza B*
Parainfluenzas (1-4a, b)*
Adenoviruses*
Rhinoviruses
Cytomegalovirus*
Varicella (zoster)*
Parvovirus B19
Measles*
Mumps
Rubella
Coxsackie B

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\*Rapid diagnosis often available.

### Conclusions

Nosocomial spread of viruses is probably more common than we realize but much of it doesn't appear to do a lot of harm. Proving that it is nosocomial, particularly in children, is difficult. How much of it we should try to prevent should be debated and the cost-effectiveness assessed. Infected children will remain in hospital longer and can spread illness further. This is important if it includes vulnerable children (immunocompromised for whatever reason; those with congenitally damaged hearts and/or lungs, etc.)—but whom do we include?

Prevention is possible, at a price, not all of which is in cash. There are real costs, for facilities, disinfectants and their use, but there are others including the effects of isolating naturally gregarious children and the hard labour of keeping precautions going for weeks, months and years. Handwashing and cohorting are the simplest, cheapest and easiest measures to institute but even they will be difficult to continue in the absence of obvious infection.

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