



# University Health Network

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## How is Influenza A Transmitted in Human Beings?\*

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Brankston *et. al.*, Lancet Infectious Diseases, 2007

# Definitions

- Standard CDC, Health Canada definitions for respiratory virus transmission:
  - Direct contact
  - Indirect contact
  - Droplet
  - Airborne



# Definitions continued

- Airborne transmission
  - Obligate
  - Preferential
  - Opportunistic

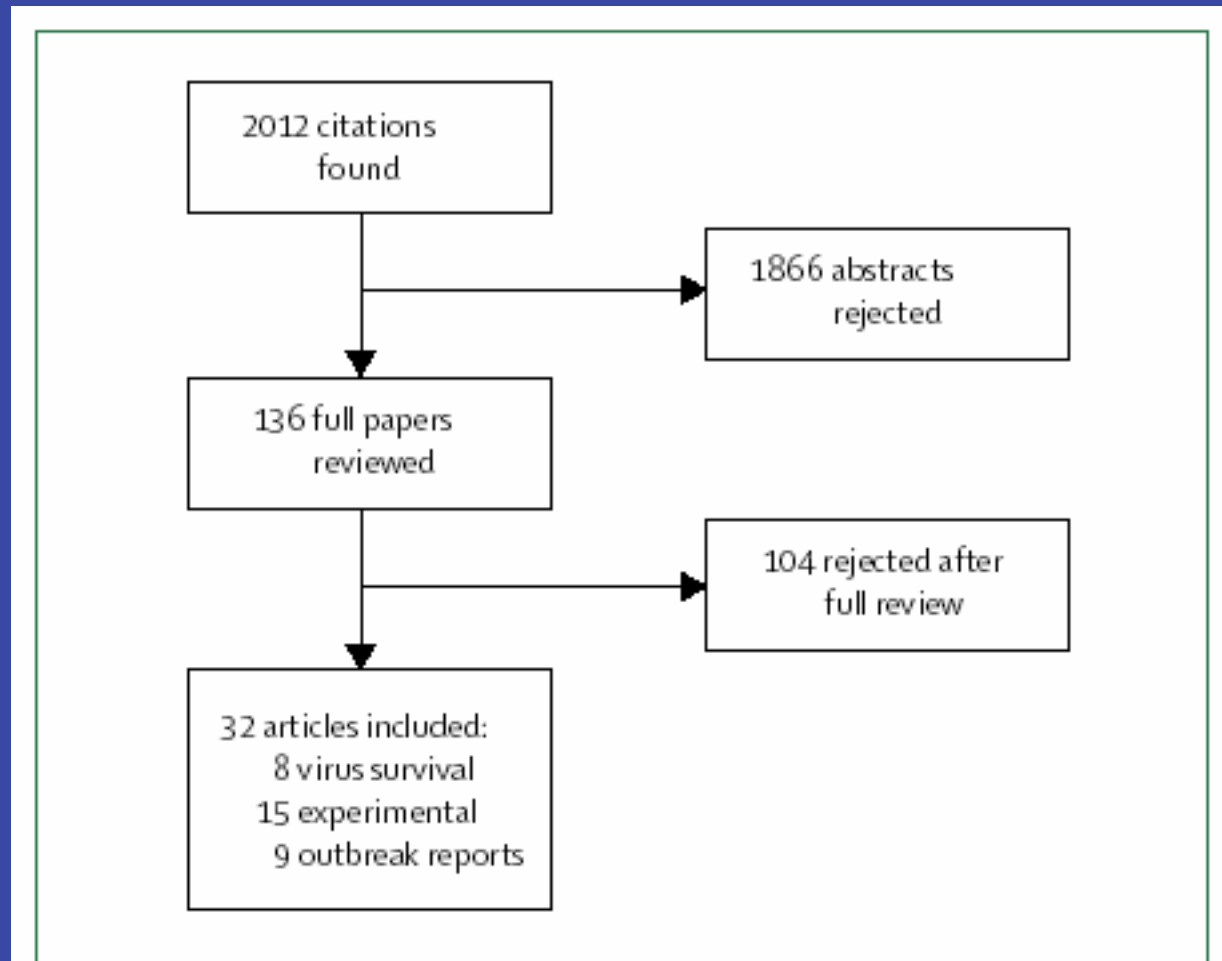


# Methodology

- Included studies on influenza transmission
  - Mammals only
  - Experimental + retrospective/prospective observational studies
  - Reports of outbreaks if included one of:
    - the type of control measures used
    - a diagram of the transmission pattern within a confined area
    - discussion of the potential route of transmission



# Methodology



**Figure:** Flow diagram of the process and results of article selection



# Results

## Categories of evidence:

1. Survival of influenza in the environment
2. Experimental infections in laboratory animals and in humans
3. Epidemiologic studies (i.e. outbreaks)



# Influenza Virus Survival in Artificial Aerosols

	Exposed cells or animal	Duration of virus survival	Virus detected 1 min after spray
Hemmes et al <sup>10</sup>			
30-40%	Chick embryos	>90 min	..
60-70%	Chick embryos	30 min	..
Loosli et al <sup>11</sup>			
>80%	Mice	1 h	..
<55%	Mice	>6-24 h	..
Wells and Brown <sup>12</sup>	Ferrets	1 h	..
Schaffer et al <sup>13</sup>			
50%	Erythrocytes	..	3-30%
70%	Erythrocytes	..	6-34%

All samples used were air samples. ..-not performed. [AQ: ok?]

**Table 1: Studies of influenza virus survival in artificial aerosols, by relative humidity**



# Survival of Different Strains

	Duration of survival (h)	
	Mitchell et al <sup>14</sup>	Mitchell and Guerin <sup>15</sup>
Human	6-15	9-16
Avian	24-36	24-36
Swine	..	16
Equine	..	21-30

..=not applicable. [AQ: ok?]

**Table 2:** Survival of different viral strains of artificially aerosolised influenza in air samples on chick embryos



# Influenza Virus Survival on Surfaces

- Influenza can be transmitted from surfaces to the hands of volunteers
- 60% of objects swabbed in the homes of sick children were contaminated with influenza virus
- Neither study investigated infection resulting from contact with contaminated objects



# Conclusions

- Artificially aerosolized influenza virus can remain airborne for varying periods of time
- Artificially aerosolized influenza virus can infect animals
  - Humidity
  - Viral strain
- Influenza virus is detectable on surfaces
- Influenza virus can be transferred from surfaces to hands



# Experimental Infections

	Animal	Method of influenza virus exposure	Diagnostic criteria used to confirm infection
■ Andrewes and Glover <sup>18</sup>	Ferrets	Exposure to animals infected via aerosol	Clinical or pathology; serology
Nakanishi <sup>19</sup>	Mice	Exposure to intranasally inoculated animals	Clinical or pathology; serology
■ Schulman and Kilbourne <sup>20</sup>	Mice	Exposure to mice infected via aerosol separated by wire mesh	Clinical or pathology
Schulman and Kilbourne <sup>21</sup>	Mice	Exposure to animals infected via aerosol	Viral isolation
Schulman and Kilbourne <sup>22</sup>	Mice	Exposure to animals infected via aerosol	Viral isolation
Schulman <sup>23</sup>	Mice	Exposure to animals infected via aerosol	Viral isolation

**Table 3: Experimental studies of animal-to-animal transmission of influenza**



# Experimental Infections

	Population	Method of influenza virus exposure	Diagnostic criteria used to confirm infection
Smorodintseff et al <sup>24</sup>	Human	Aerosol	Clinical or pathology; serology
Wells and Henle <sup>25</sup>	Mice	Aerosol	Clinical or pathology
Loosli et al <sup>26</sup>	Mice	Intranasal vs aerosol	Clinical or pathology
Alford et al <sup>27</sup>	Human	Aerosol	Clinical or pathology; viral isolation; serology
Knight <sup>28</sup>	Human	Intranasal vs aerosol	Serology
Frankova <sup>29</sup>	Mice	Intranasal vs aerosol	Clinical or pathology; antigen detection
■ Little et al <sup>30</sup>	Human	Natural vs intranasal	Serology
Snyder et al <sup>31</sup>	Squirrel monkey	Intranasal vs aerosol	Serology
Mumford et al <sup>32</sup>	Pony	Intranasal vs aerosol	Clinical or pathology; viral isolation; antigen detection; serology

**Table 4:** Experimental studies of different methods of influenza inoculation in animals and human beings



# Conclusions

- Animals can become infected by breathing aerosolized air
- Human studies involved infection via face masks
- Study comparing experimental versus natural illness in humans cannot comment on mode of transmission



# Epidemiologic studies

	N	Setting	Population	Case identification	
				Diagnostic criteria	Number (%) laboratory tested
■ Blumenfeld et al <sup>33</sup>	62	Hospital	Medical patients and staff	Viral isolation; serology	55 (89%)
■ McLean <sup>34</sup>	1116	Hospital housing tuberculosis patients	Medical patients and staff	Clinical; serology	1116 (100%)
■ Moser et al <sup>35</sup>	53	Aircraft	Healthy adults	Clinical; viral isolation; serology	Unclear
■ Klontz et al <sup>36</sup>	110	Naval base aircraft	Healthy adults	Clinical; viral isolation; serology	105 (95%)
■ Morens and Rash <sup>37</sup>	39	LTCF	Elderly residents	Clinical; viral isolation; serology	37 (95%)
■ Drinka et al <sup>38</sup>	690	LTCF	Elderly residents	Viral isolation	241 (35%)
■ Munoz et al <sup>39</sup>	15	NICU	Critical care neonates	Clinical; viral isolation; antigen detection	4 (27%)
■ Cunney et al <sup>40</sup>	54	NICU	Critical care neonates	Clinical; antigen detection	54 (100%)
■ Awofeso et al <sup>41</sup>	59	Correctional facility	Healthy adults	Clinical; viral isolation; antigen detection	21 (36%)

LTCF=Long-term care facility; NICU=neonatal intensive care unit.

**Table 5: Summary of influenza epidemiological studies**



# Conclusions

- Studies cited as providing evidence of airborne transmission did not control for multiple other factors
- Majority of studies suggest close contact important in transmission
- In no study is there clear evidence of significant long distance (airborne) transmission



# Summary

- We have been inexact in our use of the term “airborne”
- We find no evidence supporting significant degree of airborne transmission in the existing literature
- Opportunistic airborne transmission has not been demonstrated, but has not been definitively studied



# Research questions

- Can we devise a natural transmission model that excludes other forms of transmission besides airborne?
  - Riley TB experiments
- Can we quantify the relative importance of the different close contact modes of transmission?
- Is natural influenza infectious prior to the onset of symptoms?



# Research questions

- Given unanswered questions, what are the considerations that need to be balanced to ensure healthcare worker safety?
  - Compliance
  - Benefit
  - Cost
  - Potential harm



# Thank you



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