More on household transmission of SARS-CoV-2 from Wuhan

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Game plan

- Review a recent article from Wuhan province on transmission in households, that may influence thinking on who is at risk, and perhaps who should be vaccinated as priority
- Review the ‘family case report’ from last session, updated with new developments that may be instructive to clinicians and others

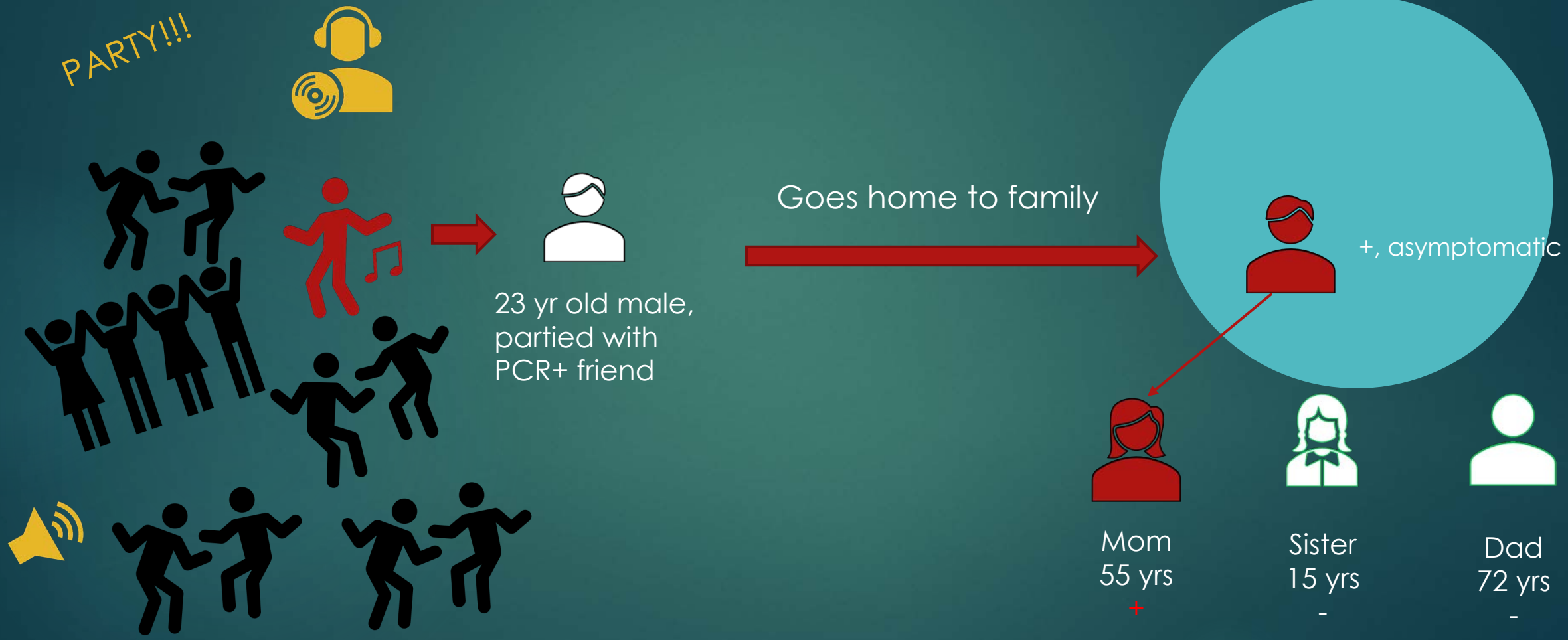
Objectives

- Cite evidence related to household transmission risk (Infectivity) and the high risk groups (susceptibility) from a very large retrospective study from Wuhan province
- Based on the recent article, suggest priority groups for SARS-CoV-2 vaccine

Case presentation—asymptomatic household transmission in California -- update

- Family of four living in Southern California
- 23 year old son, h/o liking to party, contacted by a friend who was symptomatic and tested SARS-CoV-2 positive on PCR
- 23 year old family index case, who was completely asymptomatic, tested positive by PCR
- 55 year old mom, no significant med hx, soon tested positive after a day of cough, fever, malaise
- 72 year old high-risk dad and 15 year old daughter tested multiple times and remained negative

Transmission



Outcomes of family

- Son remained asymptomatic since first test, quarantined (but did not isolate) at home
- Mom had 8 days of fever, malaise, cough; quarantined at home (did not isolate). No shortness of breath.
- Dad tested 4 times over 10 days, remained negative on PCR and no signs or symptoms of Covid-19 disease
- Daughter tested 4 times over same period, also negative on all tests and no signs or symptoms of disease

Family follow-up two weeks later….

- 15 year old sister, also reporting history of partying three weeks after her brother and mom were negative, fell ill. No sick contacts among her friends, none tested positive (!!)
- Signs and symptoms included temp elevation, malaise, headache, muscle aches
- Positive on testing for SARS-CoV-2, then isolated
- Dad remained healthy, vaccinated last week, no side effects
- Mom also vaccinated at same time (despite recency of Covid), with symptoms of fatigue, fever (temp 102), malaise, swollen nodes

Take home messages from my last talk on this topic (SQ3R approach)

- Asymptomatic people with SARS-CoV-2 infection account for about 50% of all transmission
- Effective control of infection spread will require reducing risk of transmission from asymptomatic, as well as symptomatic, Covid-19 patients

Under most reasonable set of assumptions, based on meta-analysis (from last talk):

- 59% of all transmission is from asymptomatic persons, both categories of asymptomatic combined
- From patients who never develop symptoms: account for 24%
- From patients who eventually develop symptoms: account for 35%

Take home messages from Nov 2020

- Several well-investigated case-clusters of household transmission from multiple settings now reported with widely disparate findings
- Behavioral/environmental factors most strongly associated with household transmission in Singapore were sharing a bedroom, engaging >30 minutes of conversation with index case/s
- Overall attack proportion was low (6%) among household contacts monitored very closely, possibly related to quick removal of index case from home environment to a Singapore hospital

Methods, Wuhan study 2021

- Large (huge) retrospective study
- All confirmed Covid-19 cases and asymptomatic SARS-CoV-2 infected persons in Wuhan, Dec 2019-Apr 2020
- Statistical transmission models AND real data to quantify risk factors associated with transmission and susceptibility to infection (GEE and chain binomial transmission models)
- Also considered how different levels of government-issued control measures effected the Ro over time (three time periods)
- One interesting aspect of this study relates to measuring or estimating exposure time between index cases and household members at risk using math models

Results, Wuhan study

- >27,000 households/>57,500 contacts of index cases
- Median age of index and secondary cases: 56 years
- Attack proportion overall: 15.6% (fairly stable by method used)
- People >60 years at highest risk of becoming infected
- Infants 0-1 year more likely than kids aged 2-5 years to become infected (OR 2.2)
- People age <20 years more likely to infect others (1.6 fold) compared to people >60
- Asymptomatic people 80% less likely to infect others than symptomatic patients/people

Results, Wuhan study

- Symptomatic cases more likely to infect others early in their course of disease than later when symptoms arise (OR 1.42)
- Harsh government regulations later in time reduced Ro by 50%
- Children and adolescents less likely than adults to have severe disease

	All cases (n=39 945)	Primary cases (n=29 578)	Secondary cases (n=10 367)
Age, years			
Median (IQR)	56 (43–66)	57 (44–66)	55 (39–66)
<20	908 (2·3%)	413 (1·4%)	495 (4·8%)
20–59	22 642 (56·7%)	16 892 (57·1%)	5750 (55·5%)
≥60	16 395 (41·0%)	12 273 (41·5%)	4122 (39·8%)
Sex			
Female	20 760 (52·0%)	15 417 (52·1%)	5343 (51·5%)
Male	19 185 (48·0%)	14 161 (47·9%)	5024 (48·5%)
Household size			
2	16 519 (41·4%)	13 115 (44·3%)	3404 (32·8%)
3–4	17 366 (43·5%)	12 550 (42·4%)	4816 (46·5%)
5–6	4989 (12·5%)	3276 (11·1%)	1713 (16·5%)
>6	1071 (2·7%)	637 (2·2%)	434 (4·2%)

	Mean incubation period: 5 days	
	Maximum infectious period: 13 days	Maximum infectious period: 22 days*
Secondary attack rate		
Overall	10·4% (10·1–10·7)	15·6% (15·2–16·0)
Odds of household transmission		
Household size (*vs* two people)		
3–4	0·60 (0·57–0·63)	0·59 (0·56–0·62)
5–6	0·41 (0·38–0·43)	0·40 (0·37–0·42)
>6	0·32 (0·29–0·36)	0·31 (0·28–0·35)
Epidemic phase (*vs* Jan 24–Feb 10)		
Before Jan 24	0·74 (0·69–0·79)	0·72 (0·68–0·77)
After Feb 10	0·86 (0·77–0·96)	0·86 (0·77–0·95)

Odds of infection for an exposed household contact (susceptibility)	
Age group, years (*vs* ≥60)	
0–1	0·34 (0·23–0·51)
2–5	0·16 (0·13–0·19)
6–12	0·22 (0·19–0·26)
13–19	0·27 (0·23–0·31)
20–39	0·50 (0·48–0·53)
40–59	0·69 (0·65–0·72)
Female sex (*vs* male)	1·11 (1·06–1·16)

Odds of onwards transmission for an infective case (infectivity)	
Age group, years (*vs* ≥60)	
<20	1·65 (1·32–2·05)
20–39	1·12 (1·02–1·22)
40–59	1·02 (0·95–1·09)
Female sex (*vs* male)	0·97 (0·91–1·04)
Disease severity: severe or critical (*vs* mild or moderate)	0·91 (0·84–0·98)
Diagnosis: clinical (*vs* RT-PCR)	0·75 (0·70–0·80)
Asymptomatic infection (*vs* symptomatic)	
Up to Feb 1	0·88 (0·36–2·14)
From Feb 2	0·53 (0·38–0·76)
Before symptom onset (*vs* after symptom onset)	0·76 (0·68–0·85)

Summary points, Wuhan study

- Children and adolescents less likely to become infected at home, but were more infectious to others (higher infectivity)….compared to older people (>60 years)
- Presymptomatic cases more infectious to others than later in the course of their disease when their symptoms/signs appear
- Asymptomatic cases less infectious than symptomatic cases (about 80% less)
- Harsh government measures do much to limit spread of infection—they were very effective in Wuhan (isolation of cases at home, quarantine of contacts away from home, limited ability to leave home for almost any reason….along with masking and social distancing when out)

Take home test

- Based on published data from multiple sources, who would be YOUR priority groups for initial vaccination?
- Do you think caregivers of infants less than one year of age should be a priority group for vaccine? What additional information would you want to help you decide?

References

- Fang Li et al. Household transmission of SARS-CoV-2 and risk factors. Lancet, Jan 18, 2021 www.thelancet.com/infection

- Thanks to Grazia Ori, MPH for graphics