

Characterising hepatitis C virus transmission dynamics in a high-risk incarcerated population

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Never Stand Still

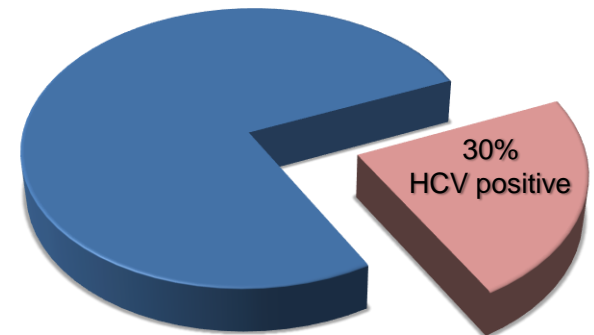
Medicine

Hepatitis C virus and incarceration worldwide

- HCV epidemic is driven by transmission in high-risk communities, notably people who inject drugs (PWID).
- PWID form a large proportion of the incarcerated population
 - 50% in the United States (*Harrison P.M., et al., Bureau of Justice Statistics Bulletin, 2005*)
 - 40% in Canada (*Public Safety and Emergency Preparedness Portfolio, 2004*)
 - 80% in Europe (*European Monitoring Centre for Drugs and Drug Addiction Annual Report, 2006*)
 - 40% in Australia (*Butler T.M., New South Wales Inmate Health Survey, 2001*)
- The global prevalence of HCV infection among prison inmates is approximately 30-40% (*Larney, S. et al., Hepatology, 2013*)

HCV in New South Wales prisons

- In New South Wales, Australia, approximately 10,000 prisoners are incarcerated due to illegal drug use:
 - 30% have been infected with HCV
 - 14% (CI: 9%-19%) HCV incidence rate in NSW prisons (*Luciani, F. et al., Addiction, 2014*)
 - 49% have reported injecting drug use (IDU) during follow-up (*Luciani, F. et al., Addiction, 2014*)



Prisoners in NSW

Kirby Institute and National Drug Research Institute. 2011.

HCV and incarceration

- NSW prisons form a highly dynamic setting consisting of multiple (n=34) centres in which prisoners are frequently moved.
 - 20,000 people incarcerated very year
 - prison sentences averaging 8 months
 - 150,000 movements per year
 - re-incarceration
- NSW prisons form an environment of high HCV incidence and prevalent injecting drug behaviour, which offers an opportunity to study ongoing HCV transmission

Hypothesis

- Integrating molecular epidemiology, prison location and temporal records, and self-reported drug-injecting behavior may **characterize HCV transmission dynamics and identify transmission clusters in a prison setting.**

Hepatitis C Incidence and Transmission in Prisons (HITS-p)

- A prospective study of 79 prisoners recruited and followed up for 12 months
- Blood samples taken at baseline and end of study
- The study compared 129 HCV seropositive prisoners with 129 HCV seronegative prisoners
 - Prison location
 - Self-reported risk factors

Characteristics	Study cohort (n=79)
Mean Age (in years)	28
Male	62%
Aboriginal	23%
Had <= 10 years education	77%
Had been previously imprisoned	87%
Ever had a tattoo	73%
Using illegal drugs during crime for which imprisoned	78%
Injected drugs in prisons	33%
Shared injecting equipment in prisons	29%
Mean duration of injecting (years)	8.3

Spatiotemporal Analysis

Methods

129 E1-HVR1 HCV sequences

```
>300280_19-10-2008
TACCAAGTGGCAACTCCACAGGCTTTACCATGTCACCAATGATGCCCTAACTCGA
>686FX_28-10-11
TATCAAGTACGCAACTCCTCGGGCTTTACCAAGTACCAATGATGCCCTAACTCGA
>300091_22-07-2009
TATGAAGTGGCAACTGTCTCGGGCTTACCATGTCACGAAGACTGCTCCACGAA
>300005_18-05-2007
TACCAAGTACGCAACTCCTCGGGCTTACCATGTCACCAATGATGCCCTAACTCGA
>300023_25-05-2009
TACCAAGTGGCAACTTACGGGGCTTACCATGTCACCAAGACTGCCCTAACTCGA
>300023_18-06-2009
TACCAAGTGGCAACTTACGGGGCTTACCATGTCACCAAGACTGCCCTAACTCGA
>300023_02-07-2009
TACCAAGTGGCAACTTACGGGGCTTACCATGTCACCAAGACTGCCCTAACTCGA
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TACCAAGTGGCAACTCCACGGGGCTTTATCATGTCACCAATGATGCCCTAACTCGA
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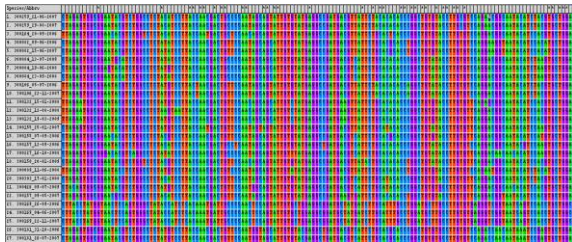
Sequence analysis

Clustering analysis

- Spatiotemporal analysis

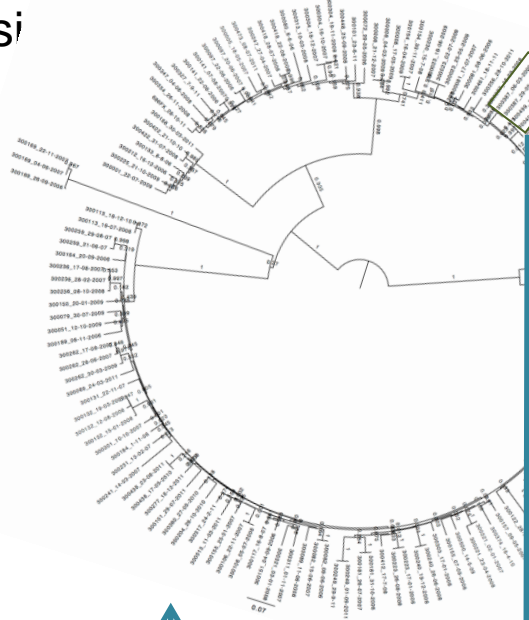
57 Genotype 1 ↔ 72 Genotype 3

ClustalW
Sequence alignment



PhyML

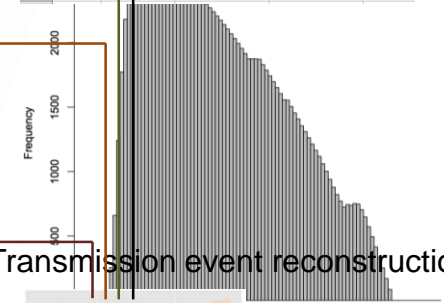
Phylogenetic tree construction



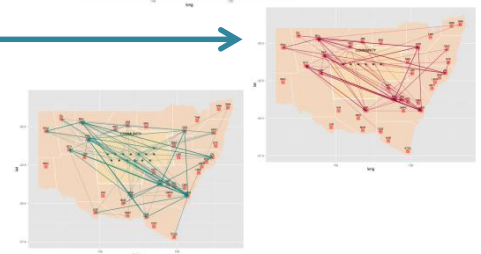
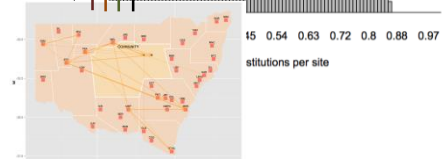
Spatiotemporal records
and injecting reports

	A	B	C	D	E
	ID	LOC	DT_IN	DT_OUT	Injecting
1	300117	MBK	31/12/07 12:55	22/01/08 12:46	0
3	300315	MBK	28/12/07 8:13	18/02/08 8:03	0
4	300461	OUTSIDE	13/11/06 14:45	29/05/08 9:32	0
5	300117	MBK	22/01/08 12:46	13/02/08 13:32	1
6	300315	MBK	28/12/07 8:13	18/02/08 8:03	1
7	300461	OUTSIDE	13/11/06 14:45	29/05/08 9:32	0
8	300117	MBK	13/02/08 13:32	17/03/08 13:28	1
9	300461	OUTSIDE	13/11/06 14:45	29/05/08 9:32	0
11	300117	MBK	26/03/08 9:04	11/05/08 14:13	1
12	300461	OUTSIDE	13/11/06 14:45	29/05/08 9:32	0
13	300315	OUTSIDE	18/02/08 8:03	14/04/08 4:13	1
14	300117	MBK	14/04/08 8:59	05/08 5:53	0
15	300461	OUTSIDE	13/11/06 14:45	29/05/08 9:32	0
16	300315	OUTSIDE	18/02/08 8:03	11/05/08 14:13	1

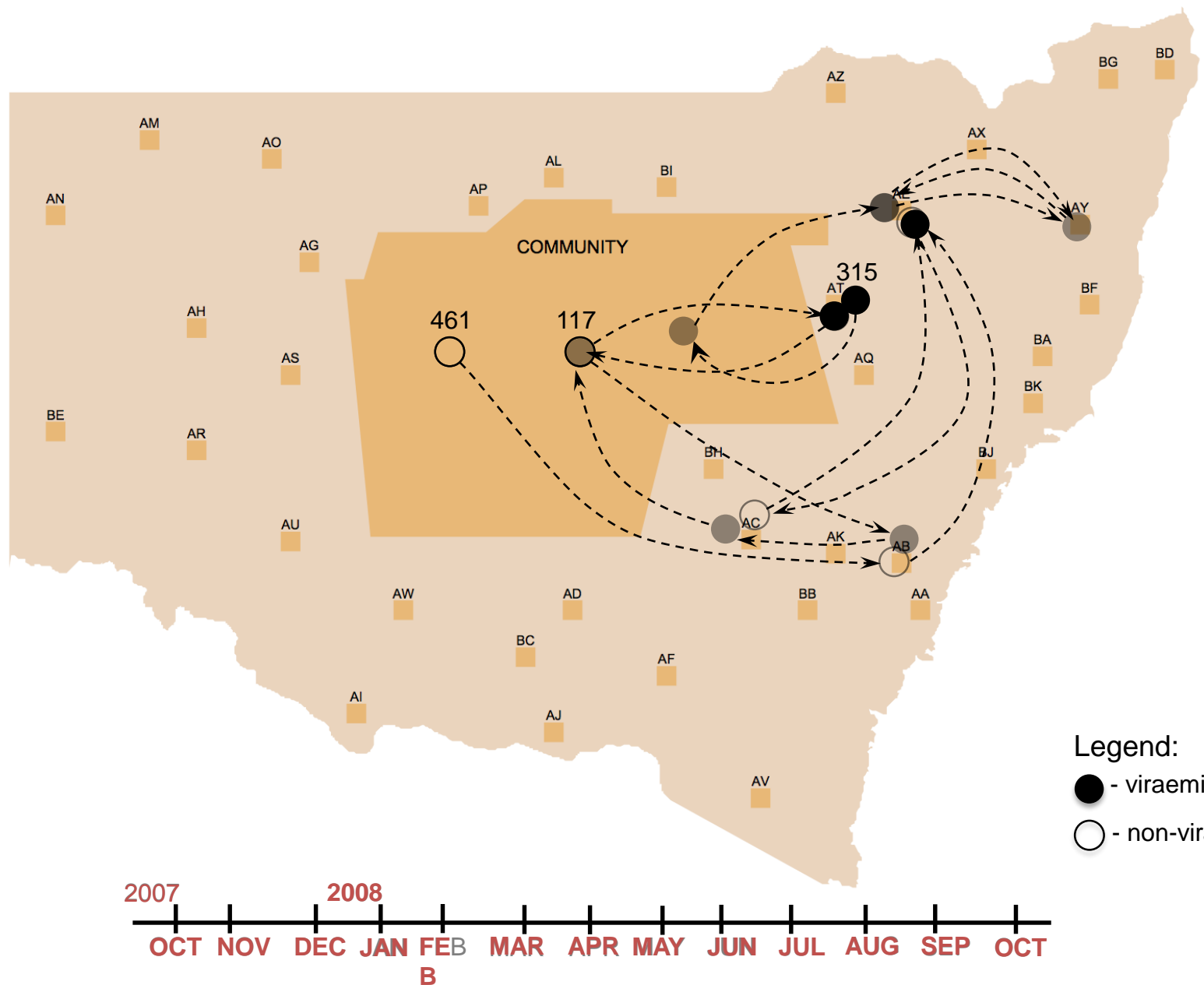
Cluster detection
Threshold
 $\text{gt} = 0.01$ $\text{gt}3 = 0.015$



Transmission event reconstruction





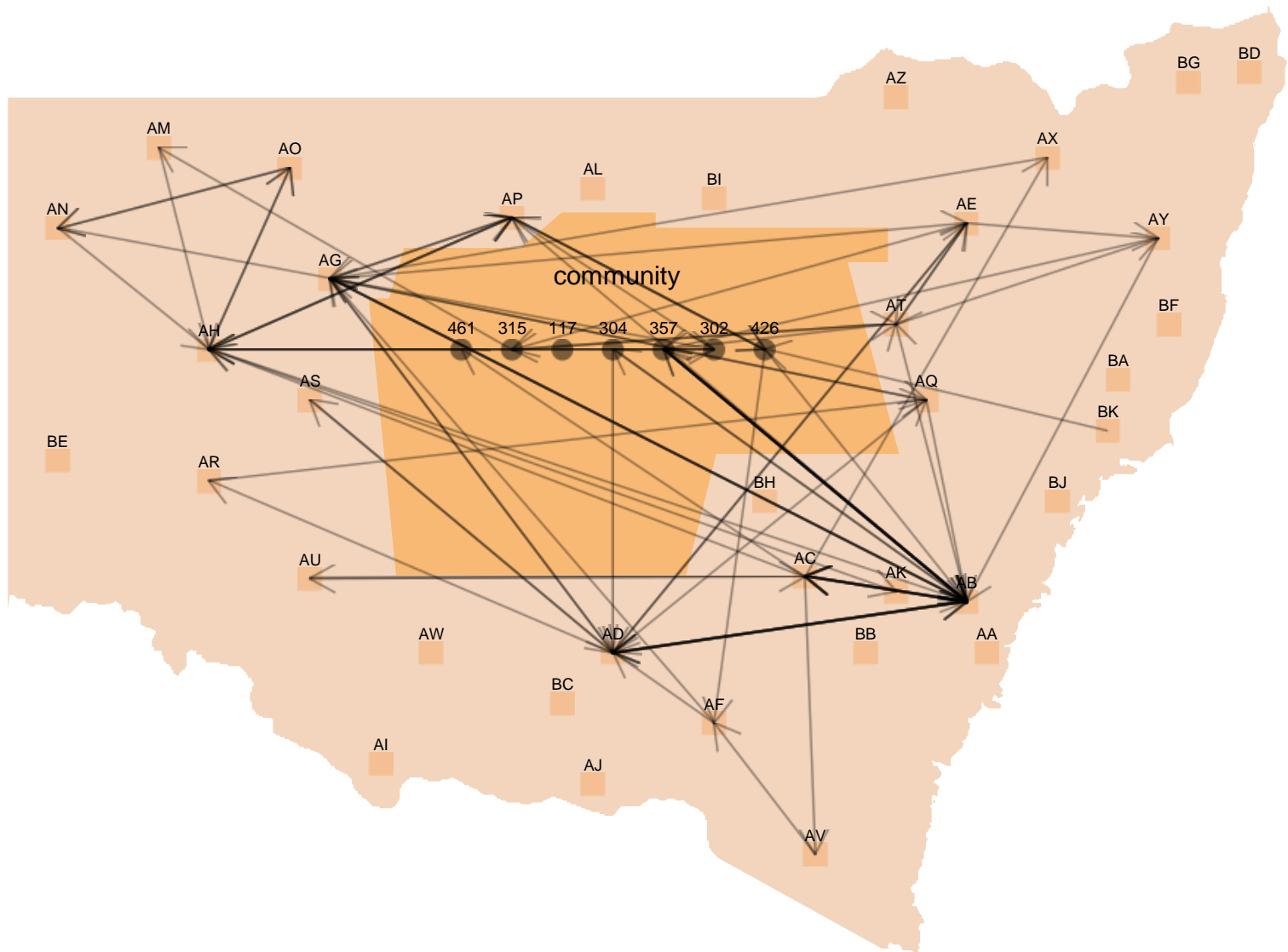


Legend:

- - viraemic
- - non-viraemic



UNSW
AUSTRALIA



Distribution of subject movements* across prisons per year (n=79)

Year	Min	Max	Mean (per year)	Median
2005	1	9	4.75	4.5
2006	1	24	9.71	9
2007	1	19	8.81	8.5
2008	1	17	8.53	8
2009	1	14	7.08	7
2010	1	17	8.27	8
2011	1	22	8.43	7.5
2012	1	14	6	5.5
Overall			7.70	

*Not including prison visits less than 24 hours.

Distribution of subject release to the outside community (n=79)

Year	Min	Max	Mean	Median
2005	0	2	0.64	0
2006	0	5	0.97	0
2007	0	2	0.79	0
2008	0	4	0.98	1
2009	0	2	0.73	0
2010	0	3	0.91	0
2011	0	6	0.91	0
2012	0	3	0.6	0
Overall			0.82	

Distribution of subject re-incarceration events (n=79)

Year	Min	Max	Mean	Median
2005	0	2	0.16	0
2006	0	4	0.44	0
2007	0	2	0.44	0
2008	0	3	0.44	1
2009	0	2	0.29	0
2010	0	2	0.42	0
2011	0	5	0.57	0
2012	0	3	0.43	0
Overall			0.4	

Conclusion

- This study describes the application of molecular epidemiological analysis with spatiotemporal and behavioral risk data to describe an ongoing epidemic in a prison setting
- PWID move often between NSW prisons and exhibit high rates of movements between prisons and between prison and community
- Despite the large prevalence of chronic HCV, highly dynamic environment, and possible underreporting of injecting behavior, evidence of recent HCV transmission clusters has been showed
- This framework may be helpful in developing programs and policies to mitigate HCV transmission in NSW prisons

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