Visceral Pleural Invasion by Tumour Size, Cancer Type and Pathologist in 1,560 Resections

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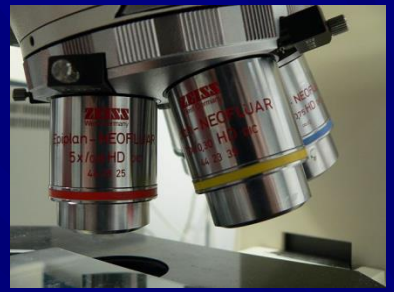
Disclosure

Dr. Bonert did the programming that was involved in this project (separate from his work duties as a pathologist / assistant professor) and thus holds the copyright on the computer code

No financial conflicts to declare

Objectives (1)
Practice Overview



How common is visceral pleural invasion (VPI) in our practice?

How does VPI vary with tumour size, diagnosis and pathologist?

Objectives (2)
Next Generation Quality

Building a framework for ...

data driven continuous improvement

Objectives (2)
Next Generation Quality

Data driven continuous improvement …

physicians generally don't know their diagnostic rates!

Luttman RJ. Next generation quality, part 1: Gateway to clinical process excellence. Top Health Inf Manage 1998;19:12-21.

Luttman RJ. Next generation quality, Part 2: Balanced scorecards and organizational improvement. Top Health Inf Manage 1998;19:22-9.

Methods and Data

Ethics approval was obtained for retrospective review

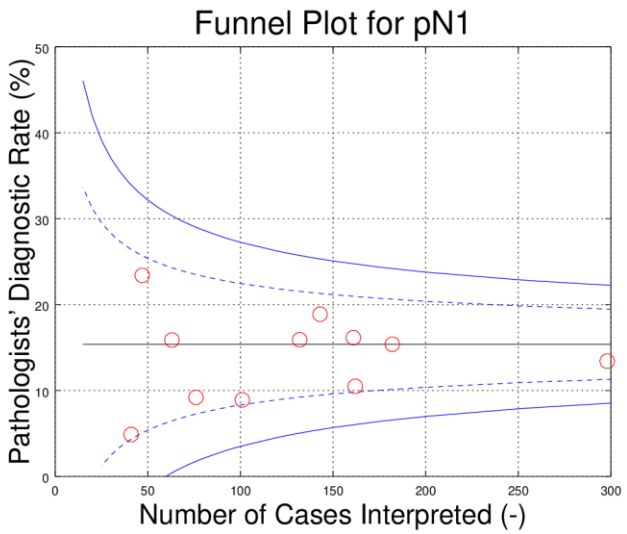
5.5 years of in house pathology reports (Jul 2012-Dec 2017) from a large thoracic surgery centre retrieved

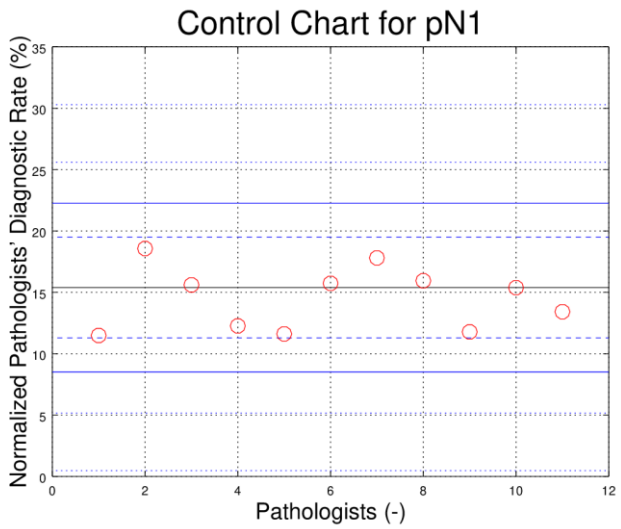
Inclusion criteria: lung resection with cancer care summary (synoptic report)

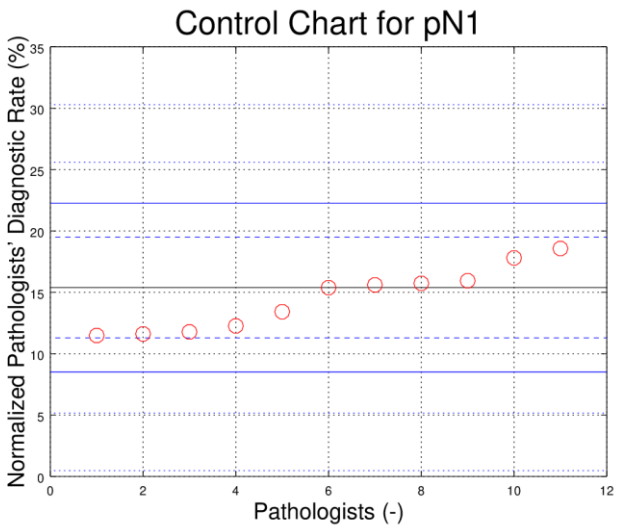
- 1,560 resections (cases)
- Data collected in separate fields (based on College of American Pathologists synoptic report) and reported centrally in Ontario (population ~14.5 million)

Methods - Funnel Plots & Control Charts

Assumptions: (1) disease rate stable over time, (2) no selection/referral bias
Funnel plots: show the call rate and the volume
Control charts: normalized to the largest case volume MD… and sorted by the rate



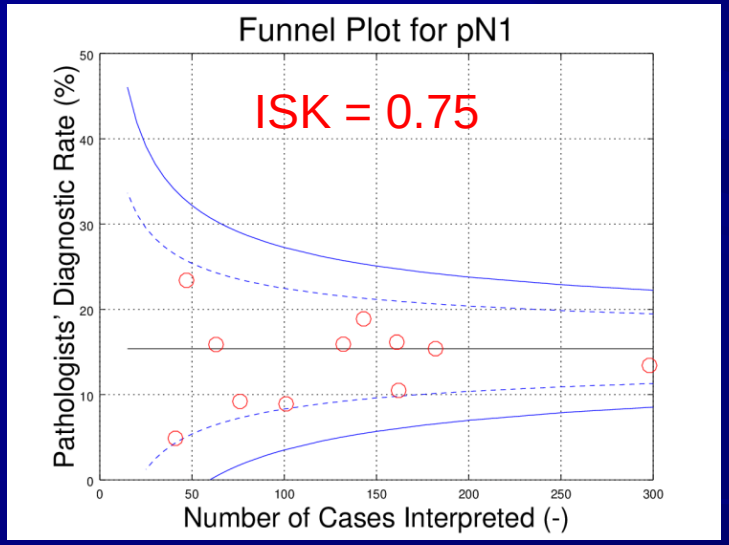




Spiegelhalter DJ, Stat Med. 2005 Apr 30;24(8):1185-202. Meyer *et al*., Ann Surg. 2009 Mar;249(3):376-83.
Bonert *et al*., J Pathol Inform 2017 23(11);8:43. Bonert et al., AIMM. 2019 doi: 10.1097/PAI.0000000000000726.

Methods - In Silico Kappa (ISK)

In silico kappa (ISK): a kappa generated from rate data… a measure of consistency
Almost identical to the “kappa max” described by Sim and Wright
Assumes raters have: *maximal diagnostic overlap – otherwise it is a Fleiss’ kappa*



ISK varies from -1 to 1 like Fleiss’ kappa

Landis and Koch Interpretation Table	
Kappa Range	**Strength of Agreement**
1 – 0.8	Almost perfect
< 0.8 – 0.6	Substantial
< 0.6 – 0.4	Moderate
< 0.4 – 0.2	Fair
< 0.2 – 0	Slight
< 0	Poor

Sim J, Wright CC, Phys Ther. 2005 Mar;85(3):257-68.
Landis JR, Koch GG, Biometrics. 1977 Mar;33(1):159-74.
Bonert M, European Congress of Pathology 2019 (PS-12 No 3) – presented Sep 9, available as e-Poster

Results – Overview (Tumour Size vs. Tumour Stage)

AJCC 7\Size	<=0	<=1 - <=0	<=2 - <=1	<=3 - <=2	<=4 - <=3	<=5 - <=4	<=7 - <=5	<20 - <=7	Sum
pTX	4	0	0	0	0	0	0	0	**4**
pT0	4	0	0	1	0	0	1	0	**6**
pT1a	0	102	312	5	0	0	0	0	**419**
pT1b	0	0	3	211	2	0	0	0	**216**
pT2a	2	8	100	106	177	130	1	0	**524**
pT2b	0	0	0	0	1	3	95	0	**99**
pT3	3	4	22	31	22	24	35	109	**250**
pT4	0	4	5	9	8	3	5	8	**42**
Sum	**13**	**118**	**442**	**363**	**210**	**160**	**137**	**117**	**1560**
Percentage	**1%**	**8%**	**28%**	**23%**	**13%**	**10%**	**9%**	**8%**	**100%**

Cumulative	**13**	**131**	**573**	**936**	**1146**	**1306**	**1443**	**1560**
% Cumulative	**1%**	**8%**	**37%**	**60%**	**73%**	**84%**	**93%**	**100%**

Notes: pT1c did not exist in AJCC 7, 60% of tumours are <= 3 cm

Results – Using T size + VPI to Approximate AJCC/UICC 8

pT by Size	Size Criteria
pT1a size	>0 and <=1 cm
pT1b size	>1 and <=2 cm
pT1c size	>2 and <=3 cm
pT2a size	>3 and <=4 cm
pT2b size	>4 and <=5 cm
pT3 size	>5 and <=7 cm
pT4 size	>7 cm

"AJCC 8"	Size only	Size + VPI	Upstaged
pT0/pTX	13	10	3
pT1a	118	105	13
pT1b	442	321	121
pT1c	363	217	146
pT2a	210	493	-283
pT2b	160	160	0
pT3	137	137	0
pT4	117	117	0
Sum	**1560**	**1560**	**0**

"AJCC 8"	Size only	Size + VPI	Upstaged
T1x	923	643	280
T2x	370	653	-283
T3/T4	254	254	0

Key points: 936 tumours are <= 3 cm and 283 of these have VPI

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pT4 size	>7 cm

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Key points: 936 tumours are <= 3 cm and 283 of these have VPI

Upstage by VPI for Stage by Size

Stage by Size	Upstaged (number)	Upstage rate (percent)
T1a size	13	11%
T1b size	121	27%
T1c size	146	40%

Key point: VPI "upstage rate" based on tumour size

e.g. 13 / 118 x 100 % = 11 %

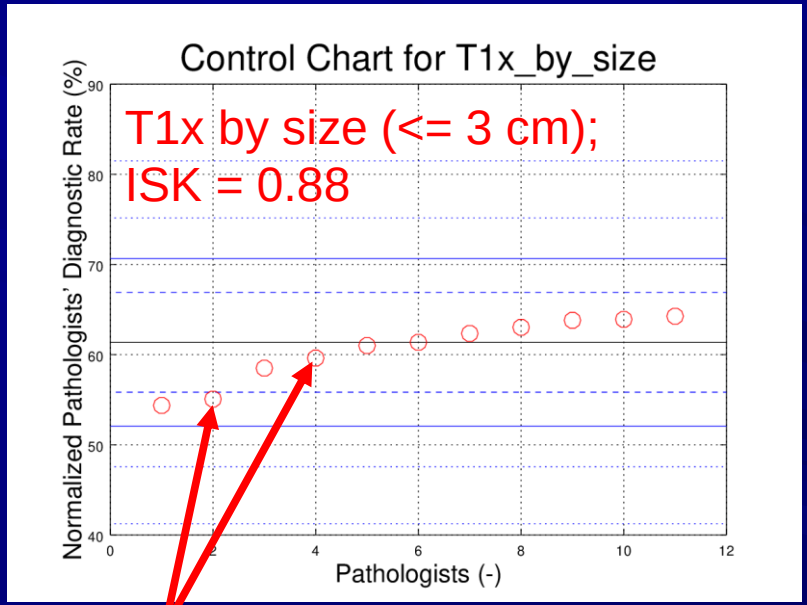
Results – Diagnosis, VPI & Tumour size

Upgrade by VPI for Stage by Size		
Stage by Size	**Upgrades (number)**	**Upgrade rate (percent)**
T1a size	13	11%
T1b size	121	27%
T1c size	146	40%

T by size	Adenoca	SCC	Other Ca	Other
T1a size	12%	9%	25%	0%
T1b size	33%	22%	26%	7%
T1c size	49%	31%	20%	10%

Key point: diagnosis has significant impact on VPI

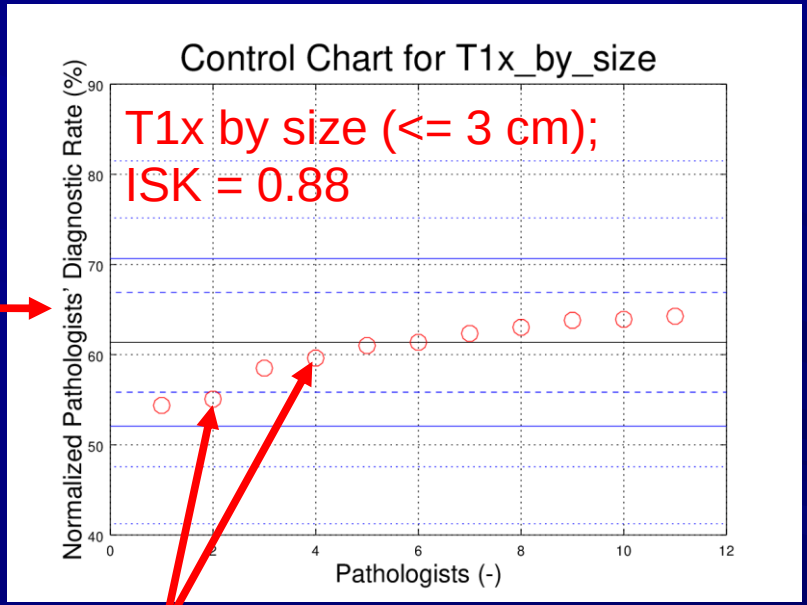
Results – Tumour Size by Pathologist



NDR ordered Pathologists

Results – Tumour Size by Pathologist

Normed Diagnostic Rate (NDR) (%)



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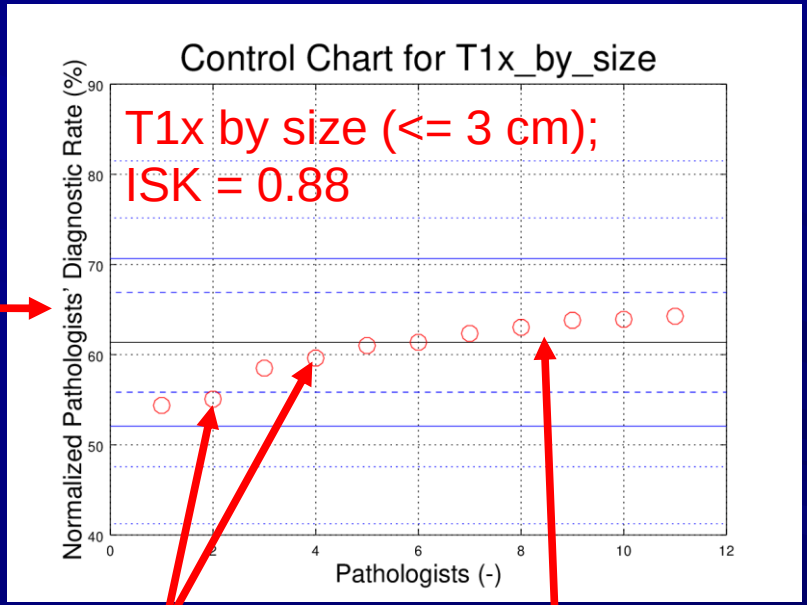
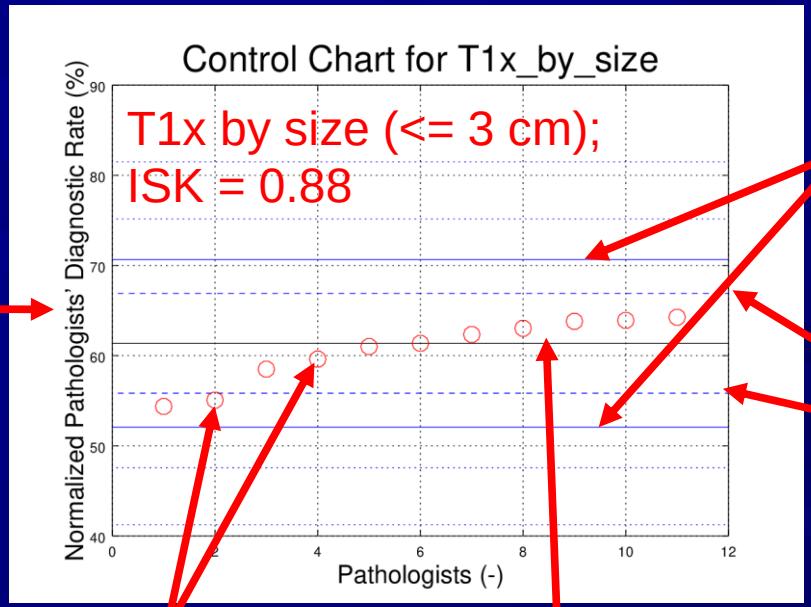


NDR ordered Pathologists

Group median

Results – Tumour Size by Pathologist



Normed Diagnostic Rate (NDR) (%)

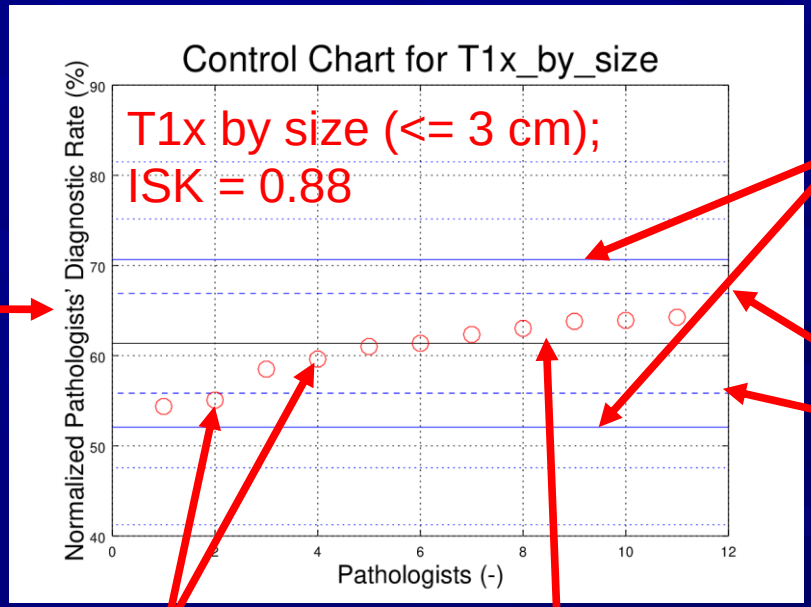
Solid control lines 99.9% CI
(if outside P<0.001)

Dashed control lines 95% CI
(if outside P<0.05)

NDR ordered Pathologists

Group median

Results – Tumour Size by Pathologist



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Solid control lines 99.9% CI (if outside P<0.001)

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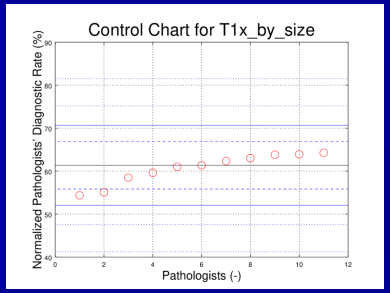
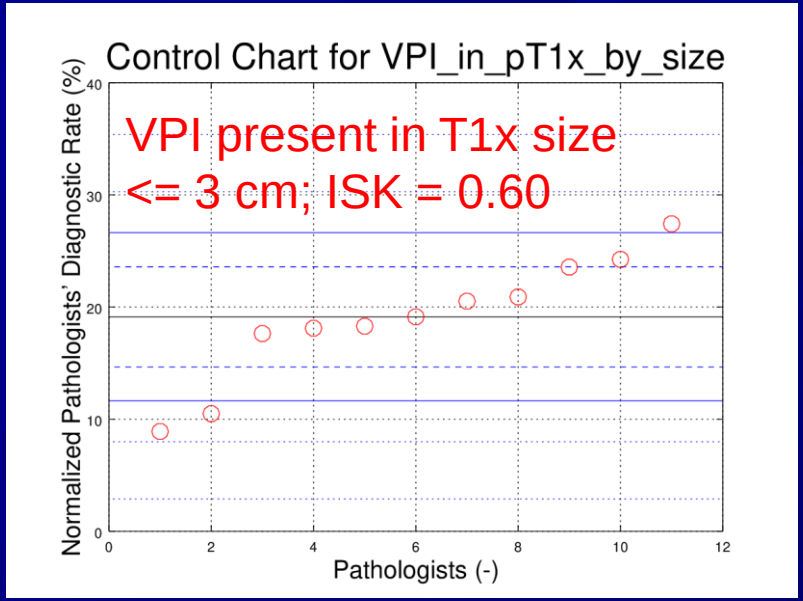
NDR ordered Pathologists

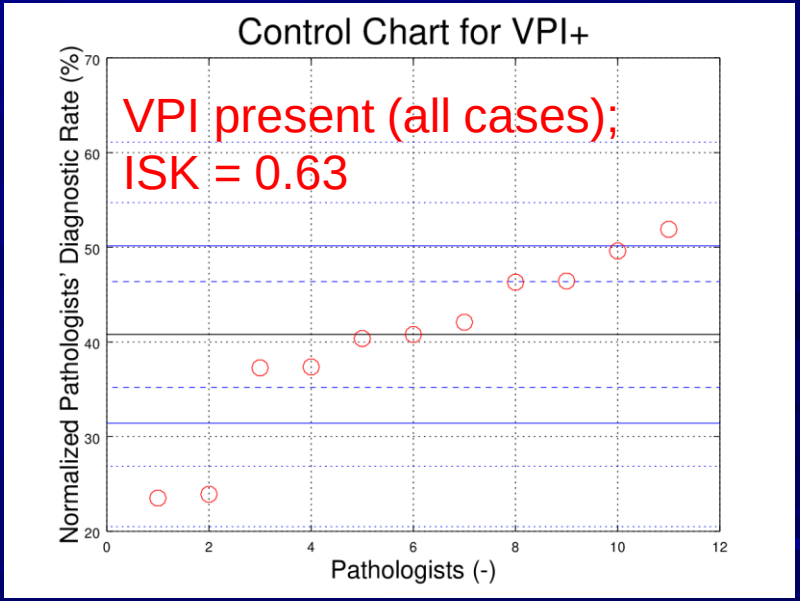
Group median

Key point: Tumours <= 3 cm almost equally distributed among pathologists

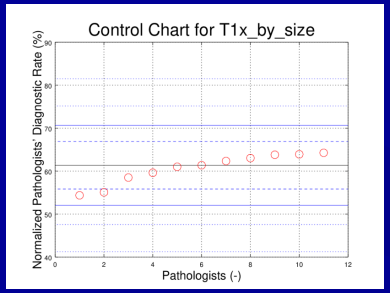


Results – VPI by Pathologist





Key point: VPI dependent on pathologist – there is room for improvement



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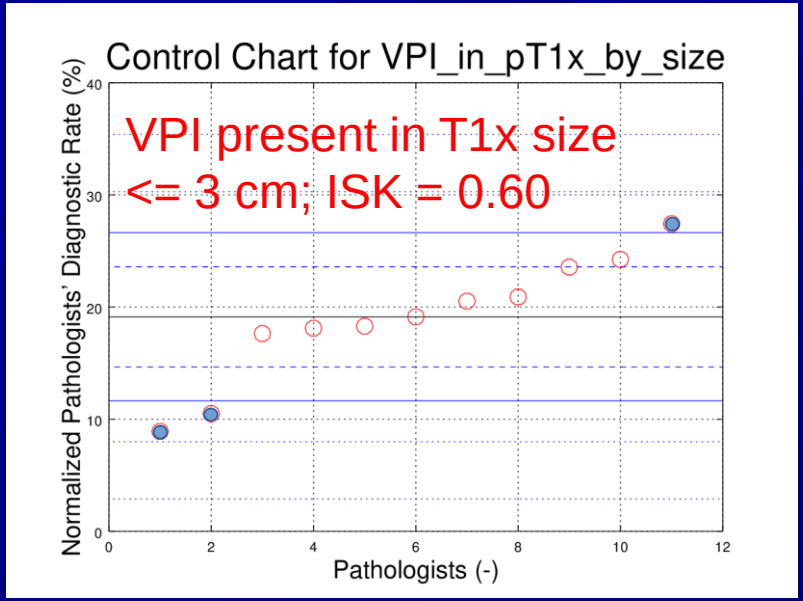

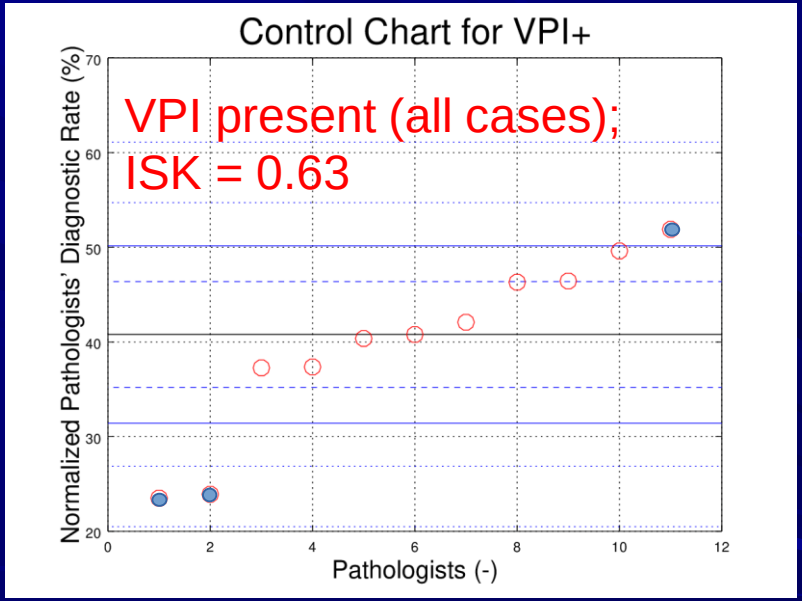

Key point: VPI dependent on pathologist – there is room for improvement

Three pathologist outliers ($p<0.001$) for VPI in each chart (light blue)

In silico kappa (ISK)

Study Parameters	ISK
T1x by size	0.88
VPI present T1x size	0.60
VPI present	0.63

Staging Parameter	ISK
pT1a	0.83
pT1b	0.75
pT2a	0.80
pT2b	0.62
pT3	0.73
pT4	0.76
pN0	0.77
pN1	0.75
pN2	0.54

Diagnosis	ISK
Adenocarcinoma	0.91
Squamous carcinoma	0.86

Other Parameters	ISK
Margin positive	0.58
LVI present	0.56
LVI present in pN0	0.48

In silico kappa (ISK)

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1 – 0.8	Almost perfect
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Key point:

ISK for VPI suggests (low) substantial agreement

ISK for staging parameters substantial agreement

ISK for diagnosis almost perfect agreement

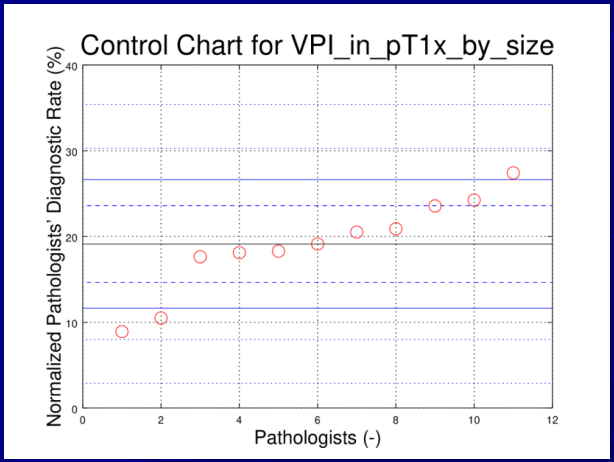
ISK for other parameters moderate agreement

Summary

- Synoptic reporting allows one to do analysis work of this type with relative ease
- VPI varies by tumour size and diagnosis
- The pathologist is a predictor of VPI
- In silico kappa is likely useful for inferring inter-rater variation

Future Work

- VPI should be juxtaposed with ancillary test use (e.g. elastin stain)
- Attempt to improve VPI call rate consistency with call rate awareness, review of criteria (Next Generation Quality)



The data suggest there may be over call and under call

What individual pathologists have to do to improve may be different – data is useful in this context!

Acknowledgments

Dr. Tamar Packer (Family Medicine)

Dr. Gary Foster (Statistics)

Dr. Becky Lin (Statistics - Toronto)

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Questions?

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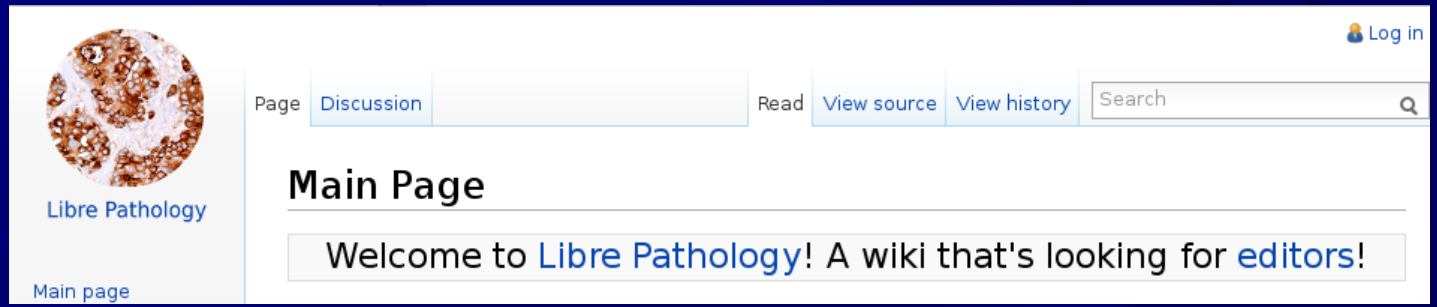

Libre Pathology (librepathology.org) – Free Pathology Information

VPI by Stage in Tumours <= 3 cm

Description	Number	Percent	VPI present	% with VPI
Tumours <=3 cm (by synoptic)	923	100%	280	30%

Description	Number	Percent	VPI present	% with VPI
pT0 tumours that are <=3 cm	1	0%	0	0%
pT1x tumours that are <=3 cm	633	69%	30	5%
pT2x tumours than are <=3 cm	214	23%	207	97%
pT3 tumours that are <=3 cm	57	6%	31	54%
pT4 tumours that are <=3 cm	18	2%	12	67%
CHECK	923	100%	280	-

Note: excludes <=0 cm tumours