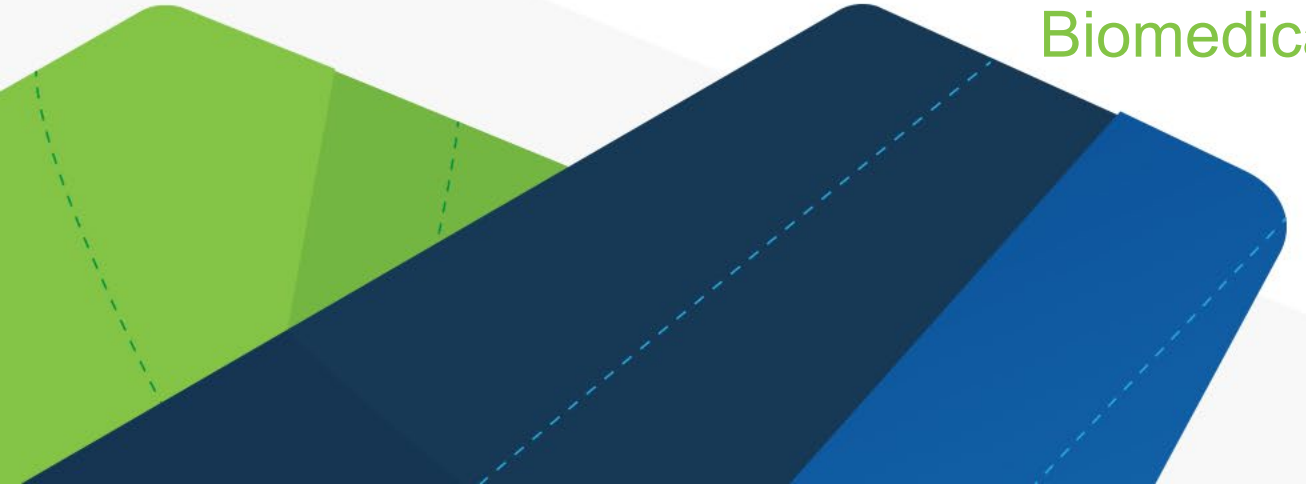
Quality Improvement Initiative: Mammography Compression Investigation

Michael Bleazard
Consultant Medical Physicist
Biomedical Technology Services, Queensland Health

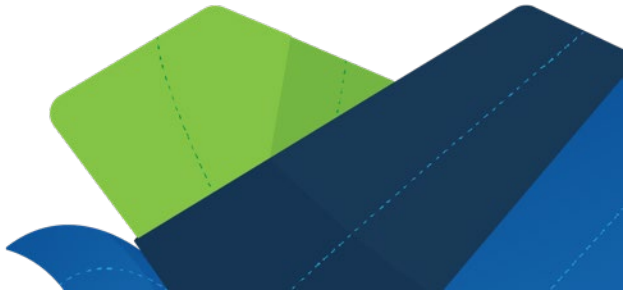


Queensland Government

Acknowledgments…& admissions

(aka the people that actually did the work)

- Timothy Ireland, Advanced Medical Physicist, BTS
- Ash Cross, Advanced Biomedical Engineer, BTS
- Jacob Arthur, Biomedical Engineer, BTS
- Karen Baker, Radiographer Imaging Consultant, BSQ
- Nick Ormiston-Smith, Epidemiologist, BSQ

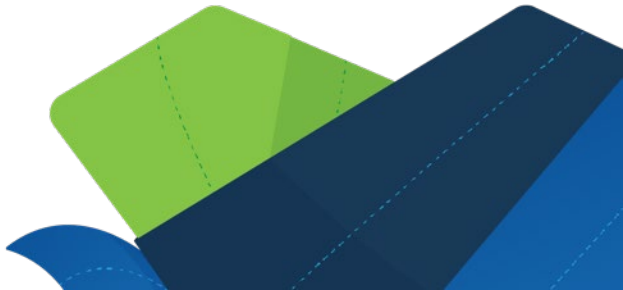


Setting the Scene

- Started as a quality improvement initiative
- BSQ is already considered a high quality service, and has rigorous processes with a focus on quality
- …but…we are always looking for opportunities to improve

- Today's focus is:

MAMMOGRAPHY COMPRESSION



The purpose of compression

Film/Screen	FFDM	Tomosynthesis
Loss of information: Uniform thickness of tissue required to avoid film saturation		
Visibility of pathology: Spread out structures of the breast to minimise overlapping pathology.		
		Improve resolution: Resolution is greatest closest to the image receptor (minimised focal spot blurring).
Reduce patient dose: Exponential radiation attenuation means that reducing the thickness of a breast by half, will reduce the dose by more than half.		
Restrict patient movement: Even minor patient movement leads to motion blur, reducing contrast in the image.		

Background

- Some studies suggest there is a need for a standardised/target compression force.
  - However, (in our opinion) this claim is not well supported.
- Studies have found a variety of “optimal” compression force and pressure values :
  - 130 N (75-140 N range)
  - 9-10 kPa (8-14 kPa range)
- Additionally, a reduction in pressure of 30% can still maintain optimal image quality.
- Holland et al. found a significant reduction in sensitivity above certain pressures (13 kPa) and a very minor reduction in specificity below certain pressures (7.7 kPa)

Radiographer Compression Training

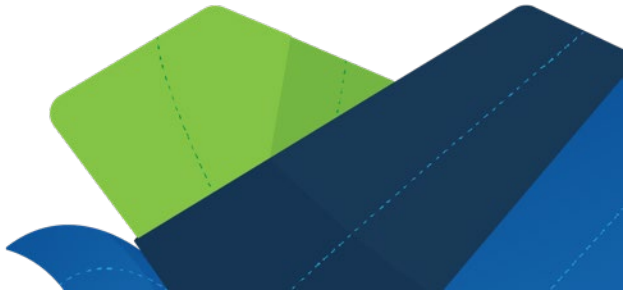
BreastScreen Queensland trains radiographers completing their Certificate of Mammography Practice (CMP) that the appropriate range of compression for adequate compression is between 50-150 Newton force.

Radiographers utilise effective communication to explain the importance of compression and that the procedure may feel uncomfortable.

Radiographers observe the breast tissue when applying compression to note that the breast tissue is firm and breast thickness can no longer be reduced.

The Physics: Force and Pressure

- Force (Newtons, N)
  - Mechanical force exerted by the compression paddle
  - Accuracy of this metric is confirmed at least annually as per NAS
- Pressure (Kilopascals, kPa)
  - Mechanical force divided by the area of the breast in contact with the paddle. i.e. The same force delivered to a smaller breast surface area would give a larger pressure
  - Theoretically a more “personalised” indication of compression.
  - Accuracy of this metric reported to be within 5%



Physics meets clinical

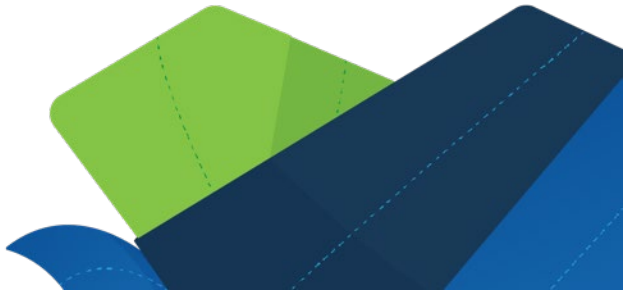
- Compression force is a physical metric.
  - The same force applied to different breasts does not have the same biological affect.
- Compression pressure is a slightly better metric being the force divided by the area of contact between the compression paddle and the breast.
  - It accounts for the area of the breast under compression
- The same force applied to a small or large breast leads to different pressures.
- Neither parameter account for individual client variation.
- The correct compression MUST be determined by the radiographer in the room.

Is there a relation between compression and recall to assessment?

- Does achieving a specific target compression (force or pressure) range impact (reduce) recall to assessment?
  - Is compression force/pressure a strong predictor of recall rates
  - Is a standardised approach possible
- If increased compression force (or pressure) improves diagnostic sensitivity, we would expect to find a difference in the recall rate for studies in the optimal compression range compared to “too low” or “too high” compression.
- If we are achieving the correct clinical indicators; positioning, compression etc, then sensitivity would be as expected.
- If we following the clinical guidelines then there should be no need to specify a target compression range.

Data sources

- Data sources:
  - Volpara (compression pressure)
    - Extracted data from March 2022, and September 2023
    - Screening only, no implants.
  - BSQR (Client Information System)
    - Recall to assessment information for studies over same period
- Intent:
  - look at what data we could access, and
  - what questions we could ask
  - If required, we could look at a wider scope of data
- There were approx.
  - Studies: March 22 = 21,000; Sept 23 = 20,000
  - Images: March 22 = 86,000; Sept 23 = 82,000
- Approx 1,000 clients recalled for assessment each month.



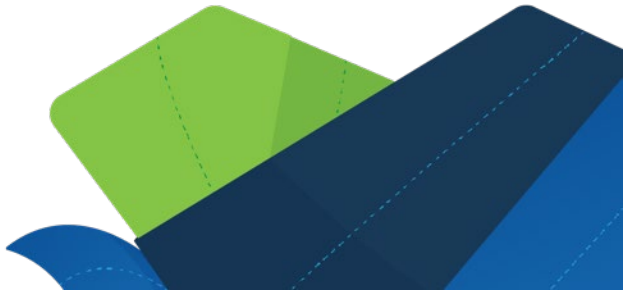
Target compression pressure

- A retrospective metric that indicates if “target compression pressure” was achieved
- Target compression pressure is between 7kPa and 15kPa
- This target range reasonably covers the compression pressures that are discussed in the current literature.

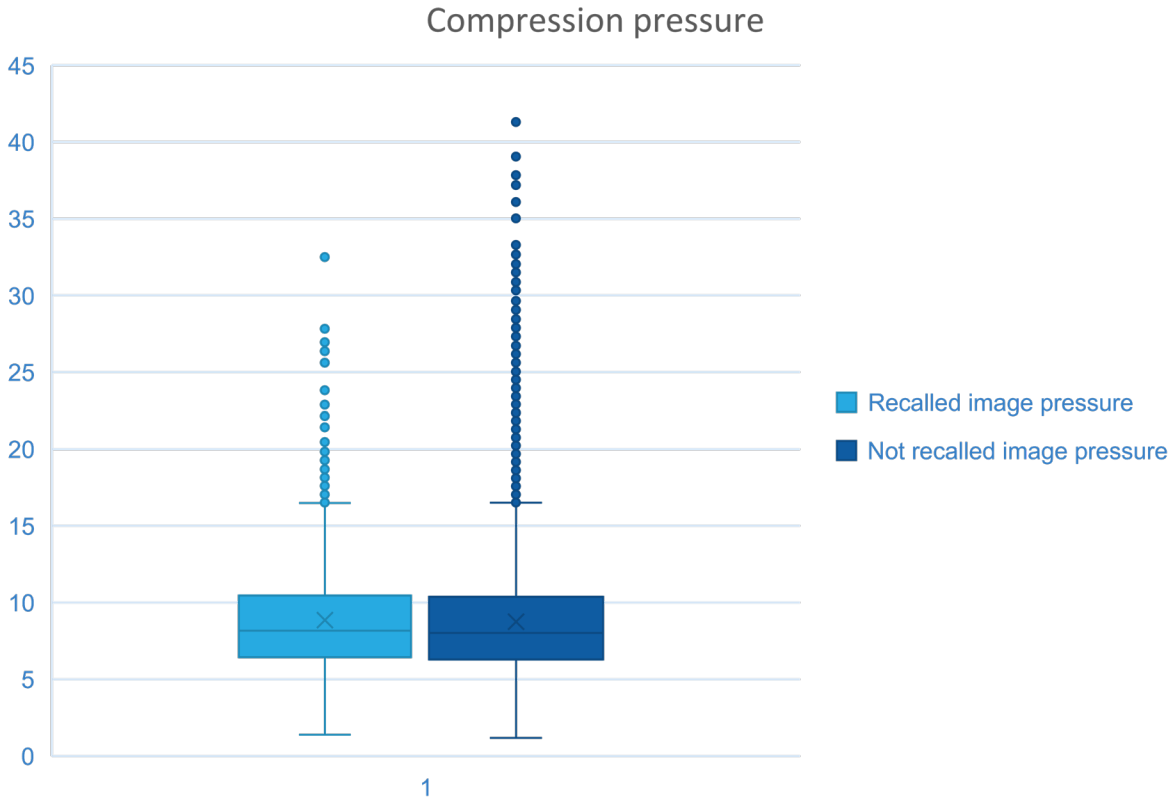
	Target Comp %
Excellent	64% or more
Above Median	57-63.9%
OK	37-56.9%
Focus	<37%

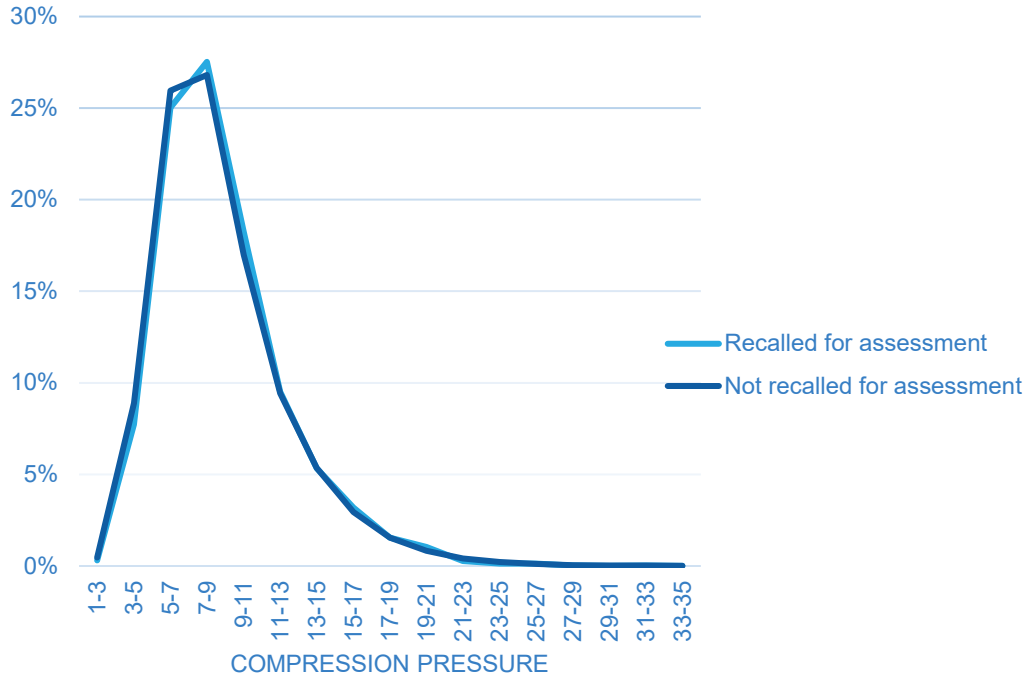
Approach

- We combined Volpara data that contains compression force and compression pressure with BSQR data that identifies which clients were recalled to assessment.
- If increased compression force (or pressure) improve diagnostic sensitivity, we would expect to find a difference in the recall rate for studies in the optimal compression range compared to “too low” or “too high” compression.



Compression pressure



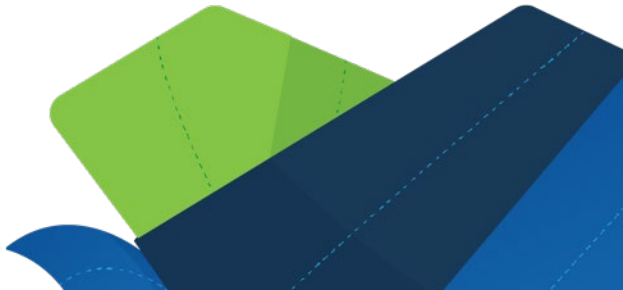


Percentage of women not recalled for assessment that reached target compression pressure: 59%

Percentage of women recalled for assessment that reached target compression pressure: 61%

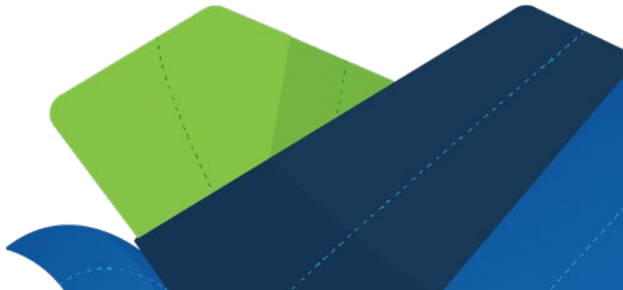
Outcomes

- The data showed no change in recall to assessment rates based on compression
  - Already operating in the optimal compression range
  - This might be different if low compression or high compression were noted
- Other possible factors (but highly unlikely to be the main drivers)
  - The affect is small and the natural variance is high. i.e. do we need more data?
  - Too much going on, and compression only improves sensitivity for specific pathologies. i.e. maybe we need to be more discriminative with the data that we are using?

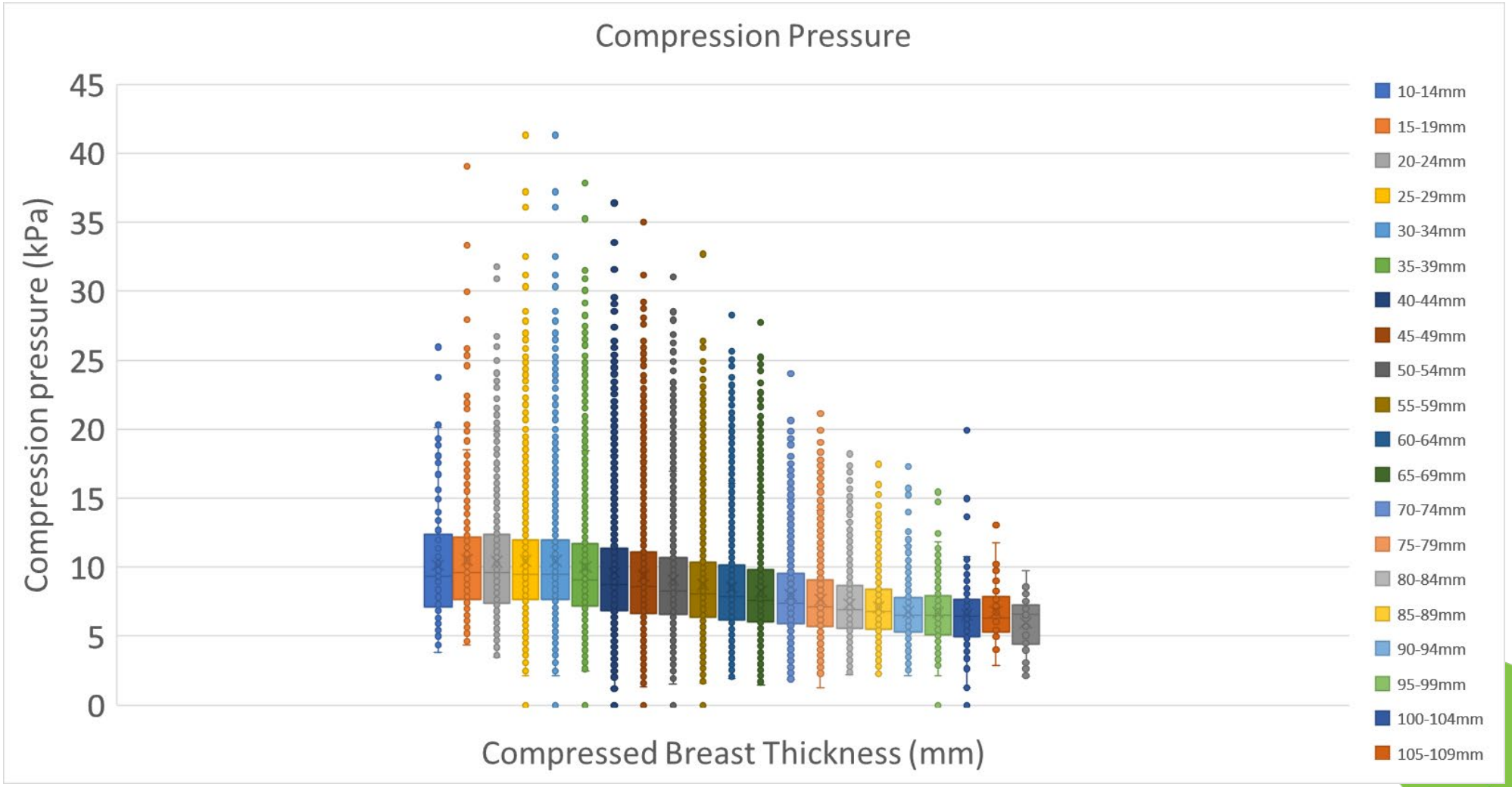


However…

- The data is still valuable
- Used for other quality improvement initiatives



Example


Compression Pressure
Compression pressure (kPa)
45
40
35
30
25
20
15
10
5
0
Compressed Breast Thickness (mm)
10-14mm
15-19mm
20-24mm
25-29mm
30-34mm
35-39mm
40-44mm
45-49mm
50-54mm
55-59mm
60-64mm
65-69mm
70-74mm
75-79mm
80-84mm
85-89mm
90-94mm
95-99mm
100-104mm
105-109mm

Case study: Individual staff

Home Service		Clinical Tutor	Studies	Images/ Study	Tech Quality Score	Study Duration	Volpara P/G Image Score	Breast Thickness (mm)	Force (N)	Pressure (kPa)	Target Comp %	Low Comp %	High Comp %
			836	4.0	2.61	03:11	57.4%	58	94		77%	19%	4%
			14	3.8	2.40	03:50	49.0%	52	96	1	76%	10%	14%
			1364	4.0	2.74	02:57	64.9%	59	108	1	74%	18%	8%
			1345	4.0	2.44	04:49	52.5%	57	97		74%	24%	2%
			1314	4.1	2.76	02:47	65.7%	54	95	1	74%	20%	6%

	Quality Score	P+G%	Target Comp %
Excellent	2.27 or more	55% or more	64% or more
Above Me	2.05-2.26	49-54.9%	57-63.9%

Services anonymised

Details

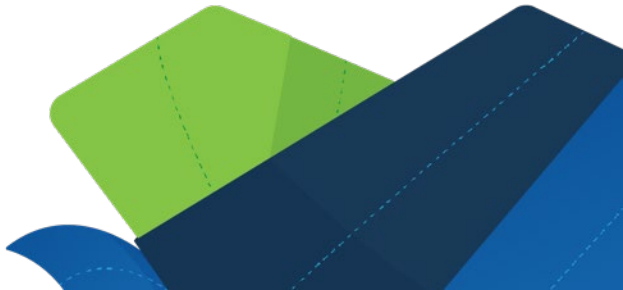
Home Service		Clinical Tutor	Studies	Images/ Study	Tech Quality Score	Study Duration	Volpara P/G Image Score	Breast Thickness (mm)	Force (N)	Pressure (kPa)	Target Comp %	Low Comp %	High Comp %
			813	4.0	1.78	03:25	50.2%	57	68	7	36%	62%	2%
			55	4.1	1.89	03:56	54.1%	71	69	8	37%	57%	6%
			1188	4.1	2.06	04:29	58.3%	63	73	7	41%	57%	2%
			565	4.0	1.86	03:25	49.7%	52	78	7	42%	55%	4%
			754	4.0	2.32	03:42	51.1%	62	87		69%	29%	2%
			116	4.0	2.26	05:49	48.5%	55	100	1	68%	18%	14%
			1747	4.0	2.66	04:08	65.7%	55	92		68%	26%	6%
			1428	4.0	2.54	04:13	60.5%	58	101	1	68%	23%	9%
			130	4.0	2.47	04:32	57.9%	55	84		68%	24%	8%
			1522	4.0	2.25	03:07	67.2%	56	115	1	67%	16%	17%
			1292	4.0	2.59	03:05	63.2%	53	87		67%	27%	6%
			1157	4.0	2.31	03:46	51.5%	53	102		67%	27%	6%

Case study: per system

Date anonymised																												
		Less than 21mm Thickness				21-32mm Thickness				33-45mm				46-53mm				54-60mm				61-75mm				76-90mm				
Service	System	Low Comp	Target Comp	High Comp	Total # of Images	Low Comp	Target Comp	High Comp	Total # of Images	Low Comp	Target Comp	High Comp	Total # of Images	Low Comp	Target Comp	High Comp	Total # of Images	Low Comp	Target Comp	High Comp	Total # of Images	Low Comp	Target Comp	High Comp	Total # of Images	Low Comp	Target Comp	High Comp	Total # of Images	Low Comp
Services anonymised	Systems anonymised	17.0%	52.5%	30.5%	54	21.3%	57.8%	20.9%	209	22.8%	58.4%	18.8%	672	29.3%	59.5%	11.2%	774	32.3%	58.4%	9.3%	1007	38.0%	56.8%	5.2%	2040	48.8%	50.2%	1.0%	883	52.6%
		12.5%	77.3%	10.2%	88	15.1%	71.3%	13.6%	388	21.1%	69.9%	9.0%	1163	26.9%	64.5%	8.6%	1335	29.6%	63.6%	6.8%	1381	35.6%	60.2%	4.2%	2111	46.5%	51.7%	1.8%	536	63.8%
		32.6%	57.6%	9.8%	88	29.6%	64.2%	6.2%	369	37.8%	57.6%	4.6%	1363	42.5%	53.4%	4.1%	1557	49.3%	48.1%	2.6%	1783	56.8%	41.5%	1.7%	2567	69.2%	30.4%	0.4%	738	80.4%
		22.7%	69.3%	8.0%	71	20.3%	72.8%	6.9%	431	24.1%	66.8%	9.1%	1466	30.9%	61.2%	7.9%	1635	37.4%	57.0%	5.6%	1717	46.4%	51.1%	2.5%	2849	59.5%	40.0%	0.5%	743	68.7%
		22.0%	66.0%	12.0%	49	20.8%	72.5%	6.7%	275	35.2%	57.6%	7.2%	1217	42.4%	52.2%	5.4%	1468	48.3%	47.3%	4.4%	1760	53.4%	44.7%	1.9%	2704	65.0%	34.7%	0.3%	659	66.7%
		18.2%	59.1%	22.7%	19	15.6%	61.9%	22.5%	209	13.8%	67.9%	18.3%	980	20.9%	65.9%	13.2%	1052	28.1%	62.6%	9.3%	1251	35.5%	59.8%	4.7%	2379	45.1%	53.4%	1.5%	739	60.2%
		16.0%	68.8%	15.2%	118	17.9%	68.7%	13.4%	558	23.2%	66.7%	10.1%	1604	32.9%	59.3%	7.8%	1725	36.8%	57.8%	5.4%	1986	48.2%	49.2%	2.6%	3511	63.3%	36.2%	0.5%	1126	75.4%
		15.3%	74.4%	10.3%	37	24.0%	71.7%	4.3%	229	26.9%	65.7%	7.4%	610	37.6%	56.9%	5.5%	599	47.2%	51.0%	1.8%	568	54.3%	44.9%	0.8%	754	60.7%	39.3%		171	73.3%
		1.7%	79.3%	19.0%	57	9.6%	73.5%	16.9%	185	16.0%	69.2%	14.8%	515	27.0%	64.8%	8.2%	801	36.0%	58.9%	5.1%	854	48.3%	49.1%	2.6%	1343	65.9%	33.6%	0.5%	374	77.3%
		29.2%	64.3%	6.5%	163	41.8%	51.4%	6.8%	449	53.8%	42.6%	3.6%	1574	61.7%	36.7%	1.6%	1544	67.0%	31.4%	1.6%	1348	75.3%	23.9%	0.8%	1571	82.5%	17.5%		294	90.2%
			100.0%		2	28.6%	62.3%	9.1%	77	27.9%	59.6%	12.5%	367	37.0%	52.4%	10.6%	511	37.3%	53.1%	9.6%	765	38.9%	55.1%	6.0%	2215	49.8%	48.3%	1.9%	1430	60.0%
			87.0%	13.0%	43	13.1%	67.9%	19.0%	183	22.5%	68.8%	8.7%	541	33.3%	58.9%	7.8%	722	38.2%	54.9%	6.9%	840	48.0%	48.8%	3.2%	1472	71.6%	28.1%	0.3%	390	94.1%
		35.8%	57.1%	7.1%	84	21.0%	70.0%	9.0%	220	33.8%	56.9%	9.3%	512	41.0%	53.8%	5.2%	590	44.6%	53.0%	2.4%	635	58.4%	40.2%	1.4%	1093	65.9%	34.1%		258	82.6%
		31.7%	58.3%	10.0%	59	34.3%	56.1%	9.6%	197	33.9%	56.0%	10.1%	808	28.2%	61.5%	10.3%	837	32.3%	59.7%	8.0%	933	36.8%	56.8%	6.4%	1751	52.6%	44.6%	2.8%	461	75.5%
			100.0%		2	5.8%	82.6%	11.6%	66	22.8%	64.0%	13.2%	312	23.0%	64.4%	12.6%	438	27.2%	64.6%	8.2%	656	32.7%	62.8%	4.5%	1225	40.1%	58.4%	1.5%	401	74.3%
			77.8%	22.2%	9	13.3%	79.5%	7.2%	82	25.3%	65.4%	9.3%	498	33.0%	58.6%	8.4%	744	38.7%	57.8%	3.5%	1022	44.2%	53.8%	2.0%	2274	57.3%	42.1%	0.6%	853	72.5%

Conclusions

- Could not find a direct link between compression and recall to assessment
  - Target compression is just one part of quality improvement reviews.
  - “Be careful what you measure, because what gets measured gets managed”.
- Clinical indicators are more relevant for determining adequate compression
- Data better used for identifying outliers in practices
  - Use as a quality improvement tool



Further work?

- Compression vs sensitivity
  - Are we compelled by the evidence?
  - Should we collect more data?
- Compression pressure vs compression force
  - Do we think that there is value in distributing a recommended compression force range with breast thickness range?
- Repeat image data
  - Do we think that there is value in trying to obtain repeated images to see if there is a difference in compression force compared to not-repeated images?


Thanks, and any questions…