Pan-Canadian Study of Reading Volumes

Andrew J. Coldman

Diane Major
Yulia D'yachkova
Jay Onysko
Norah Smith
Gregory Doyle
Norm Phillips
Rene Shumak
Nancy Wadden

Measuring Radiologist Skill

- Factors thought to influence skill
  - training, specialization, screening setting, age (of radiologist), etc.
- Volume of mammograms interpreted (usually on an annual basis) is included in
    - legislation in the United States (>480)
    - accreditation standards in Canada (>480)
    - NHS Breast Screening program standards in the United Kingdom (>5,000 annual)
    - Australian Breast Screening program (>2,000)

Pan-Canadian Study of Reading Volumes

- To determine whether the current accreditation level (>480) in Canada was adequate or whether a higher requirement would result in superior outcomes.
- A project was created in the QM committee to examine whether Canadian data could be analyzed to assist with answering this question.

Objective: To determine the relationship between the annual screening volume and radiologists' performance.

Provinces contributing to the national database were invited to participate.

Dataset (1998–2000):

- Radiologist ID, year of screen, indicator of 1st/subsequent screen and age of women at the time of screening, number of screening exams, number of abnormal screens, number of screen-detected cancers (both invasive and DCIS), number of post-screen cancers detected within 12 months of the last screen (both invasive and DCIS)

Participating Provinces

- Data were obtained from seven provinces: British Columbia (BC), Alberta (AB), Manitoba (MB), Quebec (QC), Nova Scotia (NS), Newfoundland (NFL), and Ontario (ON).

Program start date and number of radiologists by province

Province	Program Start Date	Number (%) of radiologists	Number (%) of Radiologists after exclusion*
Alberta	1990	8 (1)	6 (2)
British Columbia	1988	68 (12)	61 (20)
Manitoba	1995	10 (2)	10 (3)
Newfoundland	1996	7 (1)	6 (2)
Nova Scotia	1991	15 (3)	12 (4)
Ontario	1990	191 (33)	73 (24)
Quebec	1998	285 (49)	136 (45)
Total		**584 (100)**	**304 (100)**

*Radiologists with an average of less than 480 screens per year within the program in the interval 1998-2000 were excluded.

Number of screens by age, screening sequence, and province

		Province*							
Screen Seq	**Age**	**AB**	**BC**	**MAN**	**NFL**	**NS**	**ON**	**QC**	**Total**
First	40-49	3,169	73,008	-	-	12,654	-	-	88,831
	50-59	10,640	47,507	25,030	5,459	8,748	61,329	159,539	318,252
	60-69	3,411	29,812	11,404	1,862	4,064	27,747	94,398	172,698
	70+	1,225	16,011	-	-	1,453	11,364	-	30,053
Subse-quent	40-49	1,293	144,530	-	-	16,283	-	-	162,106
	50-59	14,022	142,958	21,033	7,331	24,675	77,770	-	287,789
	60-69	15,626	98,653	20,861	4,584	15,168	81,058	-	235,950
	70+	5,959	62,387	-	-	4,258	38,395	-	110,999
All	All	55,345	614,866	78,328	19,236	87,303	297,663	253,937	1,406,678

Number of screen-detected cancers by age, screening sequence, and province in 1998-2000

Age	AB	BC	MB	NFL	NS	ON	QC	Total
First screens								
40-49	9	190	2	0	50			251
50-59	62	270	142	24	52	419	1028	1,997
60-69	45	265	106	16	34	280	898	1,644
70+	25	196	6	0	21	186		434
Subsequent screens								
40-49	6	230	1		36			273
50-59	63	486	82	24	106	309		1,070
60-69	95	513	138	26	72	510		1,354
70+	46	413	1	5	32	315		812
Total	351	2,563	478	95	403	2,019	1,926	7,835

Distribution of radiologist reading volumes by province

	Province*							
Annual Volume	**AB**	**BC**	**MB**	**NFL**	**NS**	**ON**	**QC**	**Total**
480-699	0	1	0	0	0	19	57	77
700-999	0	1	0	0	0	16	45	62
1,000-1,499	0	4	3	6	2	13	28	56
1,500-1,999	0	6	0	0	1	8	3	18
2,000-2,999	0	9	2	0	4	11	2	28
3,000-4,999	5	32	4	0	5	4	1	51
≥5,000	1	8	1	0	0	2	0	12
Total	**6**	**61**	**10**	**6**	**12**	**73**	**136**	**304**

Outcome Measures Used

Cancer Detection Rate (**CDR**) = # screen detected cancers ÷ # screens

Abnormal Call Rate (**ACR**) = # abnormal calls ÷ # screens

Positive Predictive Value (**PPV**) = # screen detected cancers ÷ # abnormal calls

Method of analysis

- Since all the outcomes are based on counts, we chose to use a Poisson Regression Model
- The following covariates were included (to control for their effect):
  - Age (40–49, 50–59, 60–59, 70–79)
  - Screen sequence (first, subsequent)
  - Province
  - Radiologist reading volume (average annual) = (480–699; 700–999; 1,000–1,499; 1,500–1,999; 2,000–2,999; 3,000–4,999; 5000+)
  - Inter-radiologist variation, a random normally distributed factor reflecting individual radiologist performance

Poisson modelling for CDR—age, sequence, volume, and inter-radiologist variation

Factor	Level	RR	95% Post density Intervals
Age	40–49	0.49	0.44, 0.54
	50–59	1	-
	60–69	1.53	1.45, 1.61
	70–79	2.15	1.99, 2.31
Sequence	First	1	-
	Subsequent	0.62	0.58, 0.66
Radiologist Reading Volume	480–699	1	-
	700–999	1.07	0.94, 1.22
	1,000–1,499	1.02	0.90, 1.14
	1,500–1,999	1.11	0.95, 1.32
	2,000–2,999	1.20	1.01, 1.38
	3,000–4,999	1.13	0.99, 1.30
	5,000+	0.99	0.82, 1.15
Inter-Radiologist Variation	Median Difference*	1.19	1.14, 1.23

* Measures median of the difference in performance between two rads chosen at random from the group.

Poisson modelling for ACR—age, sequence, volume, and inter-radiologist variation

Factor	Level	RR	95% Post density Intervals
Age	40–49	0.99	0.97, 1.01
	50–59	1	-
	60–69	0.93	0.92, 0.94
	70-–79	0.89	0.87, 0.91
Sequence	First	1	-
	Subsequent	0.52	0.51, 0.53
Radiologist Reading Volume	480–699	1	-
	700–999	1.03	0.90, 1.13
	1,000–1,499	0.99	0.90, 1.16
	1,500–1,999	1.20	1.01, 1.40
	2,000–2,999	0.97	0.75, 1.19
	3,000–4,999	0.97	0.83, 1.09
	5,000+	0.91	0.73, 1.15
Inter-Radiologist Variation	Median Difference*	1.55	1.49, 1.61

*Median difference in performance between two rads chosen at random from the group.

Poisson modelling for PPV—age, sequence, volume, and inter-radiologist variation

Factor	Level	RR	95% Posterior density Interval
Age	40–49	0.49	0.45 ,0.55
	50–59	1	-
	60–69	1.63	1.55, 1.72
	70–79	2.39	2.22, 2.57
Sequence	First	1	-
	Subsequent	1.14	1.08, 1.21
Radiologist Reading Volume	480–699	1	-
	700–999	1.05	0.89, 1.23
	1,000–1,499	1.07	0.91, 1.26
	1,500–1,999	1.13	0.90, 1.40
	2,000–2,999	1.34	1.07, 1.65
	3,000–4,999	1.36	1.07, 1.61
	5,000+	1.37	1.06, 1.84
Inter-Radiologist Variation	Median Difference*	1.39	1.33, 1.46

*Median difference in performance between two rads chosen at random from the group .

Conclusions

- No significant inter-provincial differences in any of the outcome measurements after control for the other factors.
- Age and screen sequence significantly influenced all three outcomes, with age affecting cancer more and sequence affecting abnormal calls more.
- The random differences between radiologists significantly affected all outcomes but affected the rate of abnormal calls more strongly than cancer detection.
- Annual Screen Volume was significantly related to PPV only with increasing PPV up to 2,000 and then stability.