

Routine preoperative electrocardiogram and chest x-ray prior to elective surgery in Alberta, Canada

Électrocardiogramme et radiographie des poumons préopératoires de routine avant une chirurgie non urgente en Alberta, Canada

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Abstract

Purpose A study was undertaken to evaluate the utilization rates of routine preoperative electrocardiogram (ECG) and chest x-ray (CXR) by sex, age, and most frequent surgery type, and to estimate the total cost of these screening tests.

Methods We included all patients undergoing elective surgery in Alberta from April 1, 2005 to March 31, 2007, except those with a cancer, trauma, or cardiac diagnosis. The utilization rate was equal to the number of tests divided by the number of elective surgeries. The total cost of the tests was estimated in Canadian dollars under a health care perspective and was equal to the number of tests multiplied by the cost per test.

Results With utilization rates of 13.4% and 23.2%, routine preoperative ECG and CXR tests cost Alberta about \$369,000 and \$637,000 over 2 yrs, respectively. More than 80% of the cost was incurred by tests on patients aged 50 or older. The utilization rates of tests vary considerably among the most frequent surgeries, but not between men and women.

Conclusions Routine preoperative testing rates and costs are relatively low in Alberta. It is possible that general evidence widely disseminated over the past number of

years regarding unnecessary routines in preoperative testing has had an effect. Further interventions to reduce them would be of little value.

Résumé

Objectif Une étude a été entreprise pour évaluer les taux d'utilisation de l'électrocardiogramme (ECG) et de la radiographie des poumons (CXR) préopératoires de routine en fonction du sexe, de l'âge, et des types de chirurgie les plus fréquentes, ainsi que pour estimer le coût total de ces tests de dépistage.

Méthode Nous avons inclus tous les patients subissant des chirurgies non urgentes en Alberta entre le 1^{er} avril 2005 et le 31 mars 2007, à l'exception de ceux souffrant de cancer, de traumatisme, ou pour lesquels un diagnostic cardiaque avait été posé. Le taux d'utilisation était égal au nombre de tests divisé par le nombre de chirurgies non urgentes. Le coût total des tests a été estimé en dollars canadiens selon la perspective d'un système de soins de santé et était égal au nombre de tests multiplié par le coût par test.

Résultats Avec des taux d'utilisation de 13,4 % et 23,2 %, les tests ECG et CXR préopératoires de routine ont coûté respectivement environ 369 000 \$ et 637 000 \$ sur une période de deux ans à l'Alberta. Plus de 80% du coût a été encouru pour des tests réalisés chez des patients âgés de 50 ans ou plus. Les taux d'utilisation des tests varient considérablement selon les chirurgies les plus fréquentes, mais pas selon le sexe.

Conclusion Les taux de tests préopératoires de routine et leurs coûts sont relativement bas en Alberta. Il est possible que des données probantes générales diffusées à grande échelle au cours des dernières années concernant la

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réalisation inutile de tests préopératoires aient eu un impact. D'autres interventions destinées à réduire encore ces taux n'auraient que peu de valeur.

Introduction

“Routine” tests refer to those that are ordered according to some pre-existing rule that is never altered by the individual clinician, rather than those that are ordered according to patients’ clinical features. Many “routine” tests are ordered for asymptomatic apparently healthy individuals in the absence of any specific clinical indication.^{1A}

Routine preoperative tests may include an electrocardiogram (ECG), chest x-ray (CXR), and/or blood tests, which are performed before surgery ostensibly to detect abnormalities that may require a change in anesthetic or surgical management.^B However, existing evidence suggests that the results of tests are rarely used. The chance of detecting a true abnormality that will change clinical management is low.^{2,3} Additionally, false positive results are potentially harmful for the patients by causing stress, further testing, exposure to radiation, unnecessary therapy, and cancellation of surgery. Therefore, it is suggested that preoperative tests should only be ordered in the presence of a specific clinical indication^{1,4–6} (see footnote B).

Although guidelines are available in Canada, preoperative testing varies remarkably between hospitals. Perhaps hospitals and health regions apply the guidelines differently because the guidelines lack clarity or because clinicians ignore or disagree with the guidelines.⁴

In Alberta, there is no provincial guideline on this issue. Alberta Health and Wellness recently commissioned the Institute of Health Economics to perform a study on routine preoperative testing in the province. This paper reports the utilization rate patterns of routine preoperative ECG and CXR tests by sex and age of the patients and most frequent types of surgeries and estimates their total costs using the most recent 2-yr data available.

Methods

With consent from Alberta Health and Wellness, all patients were studied whose elective surgeries in Alberta

from April 1, 2005 to March 31, 2007 were recorded in the Alberta Hospital Discharge Database.^C Patients with a main patient service code regarding surgeries for trauma, cancer, or cardiac diagnoses were excluded because one or both tests would plausibly have been indicated for the pathology being treated.

Data on routine preoperative ECG and CXR tests were from the Physician Claims Database and the Ambulatory Care Classification System (ACCS) Database.^{D,E} Routine preoperative ECG and CXR tests were defined as those performed within 30 days⁷ before the date of surgery to the date of surgery under the following codes^F:

Physician Claims Database:

ECG:

- 03.52A: *Electrocardiogram, technical*
- 03.52B: *Electrocardiogram, interpretation*
- 03.41A: *Maximal stress electrocardiogram, technical only*
- 03.41B: *Maximal stress electrocardiogram, interpretation only*

CXR:

- X 20: *Chest—single view*
- X 20A: *Chest—single view, interpretation only*
- X 20B: *Chest—single view, technical only*
- X 21: *Chest—multiple view*

ACCS Database:

ECG: 2HZ24JAXJ

CXR: 3GY10VA

A patient with 03.41A and/or 03.41B was considered as having had one ECG. The same principle was applied to 03.52A and 03.52B. Similarly, if a patient had X 20A and/or X 20B, he/she was considered as having had one CXR. Codes X 20 and X 21 stand alone were considered as one CXR.

We excluded the tests performed within the 30 days if coded as shown in Table 1 (see footnote F).

The total cost of routine preoperative ECG and CXR tests was estimated in Canadian dollars under a health care perspective with a time horizon of 2 yrs and equal to the number of tests multiplied by the cost per test. The cost per test includes both technical and interpretation components

^C Canadian Institute of Health Information. DAD abstracting manual 2007–2008 edition, 2008.

^D Alberta Health and Wellness. Overview of administrative health databases, planning and performance branch. 2006 Aug.

^E Alberta Health and Wellness. Alberta ambulatory care reporting education session manual. 2008 Apr 1.

^F Alberta Health Care Insurance Plan. Medical procedure list as of 01 October 2007. 2007 Oct 1.

^A National Collaborating Centre for Acute Care. Preoperative tests: the use of routine preoperative tests for elective surgery: evidence, methods and guidance. National Institute for Clinical Excellence; 2003.

^B Cree M, Lier D. Routine preoperative tests—are they necessary? Institute of Health Economics, Alberta, Canada; 2007.

Table 1 Codes of the excluded tests

Codes	Description
ECG	
03.41C	Continuous, personal physician monitoring <i>Note:</i> 1. Utilizing bicycle ergometer or treadmill 2. Includes resting electrocardiograms before and after the procedure
03.41D	Intravenous dipyridamole administration for thallium imaging
03.52C	Tape ECG—ambulatory ECG monitoring record (greater than 12 hr), technical
03.52D	Tape ECG—ambulatory ECG monitoring record (greater than 12 hr), interpretation
03.55A	Phonocardiogram with ECG lead, technical
03.55B	Phonocardiogram with ECG lead, interpretation
03.56A	Carotid pulse tracing with ECG lead, non-invasive cardiac study, technical
03.56B	Carotid pulse tracing with ECG lead, non-invasive cardiac study, interpretation
03.58A	Plethysmography, impedance, interpretation
CXR	
X 21A	Thoracic inlet views
X 22	Ribs
X 23	Chest- fluoroscopy
X 24	Chest- bronchography
X 27A	Pre-breast biopsy needle localization under mammographic control, single lesion
X 27B	Pre-breast biopsy needle localization under mammographic control, multiple lesions
X 25	Chest-cardiac fluoroscopy including anter-posterior, lateral and oblique views with barium in esophagus
X 26	Mammography (one breast)
X 26A	Mammoductography
X 26B	Mammocystography
X 26C	Percutaneous stereotactic core breast biopsy imaging guidance
X 27	Mammography (both breasts)
X 27C	Screening mammography (age 40–49 yrs inclusive)
X 27D	Screening mammography (age 50–69 yrs inclusive)
X 27E	Screening mammography (age 70 yrs and over)
X 27F	Diagnostic mammography, supplementary views
X 28	Sternum and/or sterno-clavicular joint

ECG = electrocardiogram;
CXR = chest x-ray

that were paid by the Alberta Health Care Insurance Plan (AHCIP) and were recorded in the Physical Claims Database. In the ACCS database, there is no information on cost per ECG or CXR test. Therefore, we used the average cost per ECG or CXR test in corresponding years from the Physical Claims Database. Any costs incurred by false positive results, cancellations of surgery, and other intangible items were excluded from this study.

The most frequent surgeries were based on the main responsible procedure. They were the most frequent Canadian Classification of Intervention (CCI) codes of main responsible procedures in the province during the study period. The routine preoperative ECG (CXR) test rate was equal to the total number of routine preoperative ECG (CXR) tests divided by the total number of elective surgeries. Since all observations from the target population were included, no estimate of sampling variability (e.g., confidence intervals or standard errors) was required.

Stata[®] 9.2 software was used for data analyses (Stata-Corp, College Station, TX, USA).

Results

There were 38,785 patients with 44,710 surgeries in 2005/2006 and 38,847 patients with 45,702 surgeries in 2006/2007 who satisfied the inclusion criteria for this study. Within the 2 yrs, 3,136 of these patients underwent more than one surgery. Therefore, 74,496 patients with 90,412 surgeries within the 2 yrs were included for the analysis. Men accounted for 44% of the sample.

The number of surgeries, frequency, utilization rates, and costs of routine preoperative ECG and CXR tests by sex and age groups are shown in Table 2. From April 2005 to March 2007, there were 12,114 ECG and 20,952 CXR tests performed prior to 90,412 surgeries, with the

Table 2 Number of surgeries, frequency, utilization rates, and costs of routine preoperative electrocardiogram and chest x-ray tests by sex and age in Alberta from April 1, 2005 to March 31, 2007

Age group	Number of surgeries	ECG			CXR		
		Frequency	Rate (%)	Cost (\$1,000)	Frequency	Rate (%)	Cost (\$1,000)
Both sexes							
<30	11,437	188	1.6	5.6	685	6.0	20.9
30–39	7,278	244	3.4	7.1	775	10.6	23.6
40–49	13,071	1,013	7.7	30.3	2,158	16.5	65.6
50–59	16,820	2,506	14.9	75.3	3,977	23.6	121.0
60–69	17,140	3,386	19.8	103.3	5,119	29.9	155.8
70–74	8,420	1,640	19.5	50.2	2,669	31.7	81.1
74–79	8,092	1,564	19.3	47.7	2,702	33.4	82.2
80–84	5,243	1,057	20.2	32.7	1,849	35.3	56.2
≥85	2,911	517	17.8	16.2	1,019	35.0	31.0
Total	90,412	12,114	13.4	368.5	20,952	23.2	637.3
Male							
<30	5,849	81	1.4	2.4	373	6.4	11.4
30–39	2,646	94	3.6	2.8	294	11.1	8.9
40–49	4,604	409	8.9	12.2	789	17.1	24.0
50–59	7,072	1,051	14.9	31.8	1,709	24.2	51.9
60–69	8,001	1,495	18.7	45.5	2,294	28.7	69.8
70–74	3,962	736	18.6	22.8	1,215	30.7	36.9
74–79	3,867	721	18.6	22.2	1,218	31.5	37.1
80–84	2,325	448	19.3	13.9	761	32.7	23.1
≥85	1,132	186	16.4	5.8	358	31.6	10.9
Total	39,458 ^a	5,221	13.2	159.4	9,010	22.8	274.0
Female							
<30	5,587	107	1.9	3.3	312	5.6	9.5
30–39	4,632	150	3.2	4.3	481	10.4	14.7
40–49	8,467	604	7.1	18.0	1,369	16.2	41.6
50–59	9,747	1,455	14.9	43.4	2,268	23.3	69.0
60–69	9,139	1,890	20.7	57.9	2,825	30.9	86.0
70–74	4,458	904	20.3	27.4	1,454	32.6	44.2
74–79	4,225	843	20.0	25.6	1,483	35.1	45.1
80–84	2,918	609	20.9	18.9	1,088	37.3	33.1
≥85	1,779	331	18.6	10.3	661	37.2	20.1
Total	50,952 ^a	6,893	13.5	209.1	11,942	23.4	363.3

^a Two records missing information on sex were excluded

utilization rates of routine preoperative ECGs and CXRs at 13.4% and 23.2%, respectively. These tests cost Alberta about \$1 million; ECGs and CXRs accounted for 37% and 63% of the cost, respectively.

There was no significant difference between men and women in terms of utilization rates of routine preoperative ECG (13.2% vs 13.5%) and CXR tests (22.8% vs 23.4%). For both ECGs and CXRs, women accounted for 57% of both the tests and the cost. Utilization rates of tests increased with age and were highest in the 80–84 age group for both ECGs and CXRs. This pattern was found in both men and women. For both sexes, the routine preoperative

ECG test utilization rate was 4.5% among patients younger than 50 yrs of age, while this rate was 18.2% among patients aged 50 and over. The CXR utilization rate was 11.4% among the younger patients and 29.6% among the older patients. So, for ECG and CXR tests, the utilization rates among patients aged 50 and over were 4.5 and 2.7 times higher, respectively, than the utilization rates among younger patients. Tests on patients who were younger than 50 yr old accounted for <20% of the total cost.

For both sexes, the 60–69 age group had the highest number and cost of tests. With 3,386 ECGs and 5,119 CXRs performed prior to 17,140 surgeries, this age group

Table 3 Number of surgeries, frequency, utilization rates, and costs of routine preoperative electrocardiogram and chest x-ray tests by the most frequent surgeries in Alberta from April 1, 2005 to March 31, 2007

Most frequent surgeries	Number of surgeries	Electrocardiograms			Chest x-rays		
		Frequency	Rate (%)	Cost (\$1,000)	Frequency	Rate (%)	Cost (\$1,000)
Knee replacement	10,285	2,395	23.3	70.0	3,113	30.3	94.5
Hip replacement	6,989	1,566	22.4	45.0	1,994	28.5	60.5
Hernia	4,451	791	17.8	25.3	1,006	22.6	30.6
Breast surgery	4,891	847	17.3	26.1	1,535	31.4	46.8
Cholecystectomy	2,947	445	15.1	14.0	426	14.5	13.0
Hysterectomy	3,215	88	2.7	2.5	376	11.7	11.4
Thyroid gland excision	1,681	179	10.6	5.6	285	17.0	8.7
Inter-vertebral disc surgery	1,931	235	12.2	7.3	571	29.6	17.3
Prostatectomy	1,145	61	5.3	2.0	168	14.7	5.1
Cystectomy	726	30	4.1	0.9	113	15.6	3.4
Rotator cuff repair	652	199	30.5	6.2	66	10.1	2.0
Tonsils and adenoids excision	567	3	0.5	0.1	5	0.9	0.1
Partial rectum excision	598	137	22.9	4.4	290	48.5	8.8
All other procedures	50,334	5,139	10.2	159.2	11,004	21.9	334.9
Total	90,412	12,114	13.4	368.5	20,952	23.2	637.3

cost Alberta about \$260,000 (26% of the total cost) for 2 yrs. This age group also had the highest number of surgeries. These patterns were true in men for both the ECG and CXR tests and in women for the CXR tests. For ECG tests in women, 50–59 was the age group with the highest number of surgeries. However, with a lower utilization rate, this female age group had a lower number and cost of tests compared with the 60–69 female age group.

Table 3 shows the number of surgeries, frequency, utilization rates, and costs of preoperative ECG and CXR tests by most frequent surgeries. The highest ECG utilization rate (30.5%) was found in rotator cuff repair surgery. The ECG utilization rates for knee and hip replacements—the two most frequent surgeries—were 23.3% and 22.4%, respectively. Partial rectum excision had the highest rate of CXRs (48.5%). Surgeries that had the lowest ECG and CXR rates were tonsil and adenoid excisions (both around 1%). With the highest number of tests, knee and hip replacement surgeries also had the highest cost of tests. Routine preoperative ECG tests for knee and hip replacements cost Alberta about \$70,000 and \$45,000, respectively, and the costs for CXR tests were \$95,000 and \$60,000, respectively.

Discussion

Generally, utilization rates of routine preoperative ECGs and CXRs in Alberta were 13% and 23%, respectively. These tests cost Alberta about \$1 million for the 2 yrs from April 1, 2005 to March 31, 2007. The ECG rate is lower than that reported by Hux for Ontario, but the CXR rate is

higher.⁷ However, if we compare savings, Ontario's is much higher for both ECGs and CXRs. According to Hux,⁷ Ontario's utilization rates of routine preoperative ECG and CXR tests are 29% and 13%, respectively. Elimination of routine ECGs and CXRs in low-risk groups of patients in Ontario represents a savings of more than \$800,000 and \$2 million over 2 yrs, respectively.⁷ If the low-risk group is defined as patients younger than 50 yrs, the corresponding annual savings in Alberta would be \$48,000 and \$120,000. Since Ontario's population is larger than Alberta's, and it has more patients and hospitals and possibly higher costs for tests, it is less meaningful to compare absolute numbers of tests and costs between the two provinces. However, the utilization rates and cost patterns can be compared.

Although there are differences in utilization rates, there are similarities between Alberta and Ontario regarding their cost patterns. Compared with ECGs, CXRs account for a larger share of the total cost in the two provinces. CXRs accounted for 71% and 63% of the total cost of preoperative testing in Ontario and Alberta, respectively. The corresponding numbers for ECGs are 29% and 37%, respectively.

The cost of routine preoperative tests in this study is much lower than the cost estimated by Cree and Lier (footnote B), where routine preoperative CXR cost alone is reported to be \$5.4 million annually. Perhaps this cost was overestimated, because the data on the number of elective surgeries per capita at Capital Health Region (Edmonton) and the data on utilization rate and cost of tests at a tertiary care hospital were extrapolated to the whole province.

Their data showed a rate of 31 elective surgeries per 1,000 population in the Capital Health Region during the study period, similar to the rate of elective surgeries in the Calgary Health Region but 1.6 to 4.5 times higher than the rate in other regions. Furthermore, a cost of \$110 per CXR test in a tertiary care hospital⁸ was used to estimate the potential savings in their report. This cost is more than three times higher than the cost per CXR test (multiple view, both technical and interpretation) paid by AHCIP (\$33.15) used in this study (footnote F).

It is not surprising that the probability of having the tests is dependent on the age of the patients, i.e., the older the patient, the higher the chance of having the tests. There are several hospitals recommending preoperative testing on any patients who reach a certain age. For example, an ECG is suggested for male and female patients who are older than 45 and 50 yrs of age, respectively, at the University of Wisconsin Hospital and Clinics.^G In Capital Health, Alberta, an ECG is recommended for all patients who are 60 yr old and over.^H However, some guidelines suggest that age alone should not be the indication to order the tests.⁹ Rather, the tests should be ordered according to patients' clinical features.

Our results show that men and women have the same probability of having preoperative ECG and CXR tests. No study regarding sex differences in the probability of having a preoperative test was found for discussion.

Regarding the utilization rate variation among the most frequent surgeries, an explanation might be the differences in perioperative anesthetic and surgical risk. For example, hip and knee replacements are intermediate risk surgeries. Therefore, the utilization rates among these surgeries are much higher than among tonsil and adenoid excisions which are lower-risk surgeries.⁷

Although utilization rates are generally low, certain practice should be re-considered. For instance, there were 1,198 patients who had more than one ECG (11.3% of all patients with ECG tests) and 2,132 patients who had more than one CXR (11.8% of all patients with CXR tests) within 1 month preceding surgery. Since many guidelines recommend that an ECG be taken within 3 months and a CXR be taken within 6 months of scheduled surgery, this practice should be acceptable unless there has been a change in the patient's medical status.^{4,10} Further investigation regarding these patients may be needed.

There are some limitations of this study. It could be argued that the utilization rates of routine preoperative tests

are underestimated because the tests performed on the date of surgery in hospital are not recorded in the claim or ACCS databases seeing as the hospital has to pay for these tests.¹ However, we believe this to be a small number. There were only 14 ECG and six CXR procedures recorded in 90,412 discharge abstracts of 74,496 patients in this study.

Another limitation is the relatively small number of observations, which did not allow us to calculate the utilization rates by smaller groups. For example, we could not calculate the utilization rates by sex and age and the most frequent surgeries.

In conclusion, utilization rates of routine preoperative ECG and CXR tests are relatively low in Alberta. With utilization rates of 13% and 23%, routine preoperative ECG and CXR tests cost Alberta about \$368,000 and \$637,000 over 2 yrs, respectively. More than 80% of the cost was incurred from tests on patients aged 50 or older; i.e., the older the patient, the higher the risk of having the tests. The utilization rates vary considerably among the most frequent surgeries but not between men and women. It is possible that general evidence on unnecessary routines in preoperative testing widely disseminated over the past number of years has had an effect. Further interventions to reduce them would be of little value.

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Conflicts of interest None declared.

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^G University of Wisconsin Hospital and Clinics. Preoperative testing suggestions. 2008.

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