# Innovative practice model to optimize resource utilization and improve access to care for high-risk and *BRCA*+ patients

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**Background:** Bilateral prophylactic mastectomy (BPM) has shown breast cancer risk reduction in high-risk/*BRCA*+ patients. However, priority of active cancers coupled with inefficient use of operating room (OR) resources presents challenges in offering BPM in a timely manner. To address these challenges, a rapid access prophylactic mastectomy and immediate reconstruction (RAPMIR) program was innovated. The purpose of this study was to evaluate RAPMIR with regards to access to care and efficiency.

**Methods:** We retrospectively reviewed the cases of all high-risk/*BRCA*+ patients having had BPM between September 2012 and August 2014. Patients were divided into 2 groups: those managed through the traditional model and those managed through the RAPMIR model. RAPMIR leverages 2 concurrently running ORs with surgical oncology and plastic surgery moving between rooms to complete 3 combined BPMs with immediate reconstruction in addition to 1–2 independent cases each operative day. RAPMIR eligibility criteria included high-risk/*BRCA*+ status; BPM with immediate, implant-based reconstruction; and day surgery candidacy. Wait times, case volumes and patient throughput were measured and compared.

**Results:** There were 16 traditional patients and 13 RAPMIR patients. Mean wait time (days from referral to surgery) for RAPMIR was significantly shorter than for the traditional model (165.4 v. 309.2 d, $p = 0.027$). Daily patient throughput (4.3 v. 2.8), plastic surgery case volume (3.7 v. 1.6) and surgical oncology case volume (3.0 v. 2.2) were significantly greater in the RAPMIR model than the traditional model ($p = 0.003$, $p < 0.001$ and $p = 0.015$, respectively).

**Conclusion:** A multidisciplinary model with optimized scheduling has the potential to improve access to care and optimize resource utilization.

**Contexte :** La mastectomie prophylactique bilatérale (MPB) donne lieu à une réduction du risque de cancer du sein chez les patientes à risque élevé/*BRCA*+. Toutefois, la priorité accordée aux cancers évolutifs alliée à une utilisation inefficace des ressources dans les blocs opératoires pose des défis lorsqu'il est question d'offrir la MPB sans retard. Pour relever ces défis, un programme d'accès rapide à la mastectomie prophylactique et à la reconstruction immédiate (RAPMIR) a été mis de l'avant. Le but de cette étude est d'évaluer le programme du point de vue de l'accès aux soins et de l'efficience.

**Méthodes :** Nous avons passé en revue de manière rétrospective tous les cas de patientes à risque élevé/*BRCA*+ ayant subi une MPB entre septembre 2012 et août 2014. Les patientes ont été scindées en 2 groupes : 1 groupe a été soumis au modèle thérapeutique standard et l'autre, au modèle RAPMIR. Le modèle RAPMIR met à contribution 2 blocs opératoires fonctionnant concomitamment où l'oncologie chirurgicale et la chirurgie plastique alternent entre les salles pour réaliser 3 MPB concurremment avec des reconstructions immédiates, en plus d'un ou 2 autres cas distincts à chaque journée opératoire. Les critères d'admissibilité à RAPMIR incluaient : risque élevé/*BRCA*+, MPB avec reconstruction immédiate à l'aide d'implants et admissibilité à la chirurgie d'un jour. On a mesuré et comparé les temps d'attente, les volumes de cas et le nombre de patientes.

**Résultats :** L'étude a regroupé 16 patientes soumises au modèle standard et 13 au modèle RAPMIR. Le temps d'attente moyen (nombre de jours entre la consultation et la chirurgie) pour RAPMIR a été significativement plus bref que pour le modèle standard (165,4 c. 309,2 jours, $p = 0{,}027$). Le nombre de patientes/jour (4,3 c. 2,8), le volume des cas de chirurgie plastique (3,7 c. 1,6) et le volume des cas d'oncologie chirurgicale (3,0 c. 2,2) ont été significativement plus élevés avec le modèle RAPMIR qu'avec le modèle classique ($p = 0{,}003$, $p < 0{,}001$ et $p = 0{,}015$, respectivement).

**Conclusion :** Un modèle multidisciplinaire reposant sur une synchronisation optimisée a le potentiel d'améliorer l'accès aux soins et l'utilisation des ressources.

There is a strong body of evidence supporting the use of bilateral prophylactic mastectomy (BPM) as a means of reducing the risk of breast cancer in moderate- to high-risk women, including those with *BRCA1* and *BRCA2* mutations (*BRCA*+).[1–4] Although there are no randomized trials, a 2010 Cochrane review found that BPM was effective at reducing both the incidence of, and death from, breast cancer.[3] In their retrospective review, Hartmann and colleagues[1] found a risk reduction of 89.5% and 90% for the moderate- and high-risk groups, respectively.[1] Risk reductions of approximately 90% for BPM in patients with *BRCA* mutations have been noted in other literature as well.[2] Schrag and colleagues[6] leveraged Markov modelling[5] and estimated that a 30-year-old woman carrying a *BRCA* mutation would gain 2.9–5.3 years of life expectancy from prophylactic mastectomy.

In 2007, the Society for Surgical Oncology issued a position statement addressing prophylactic mastectomy.[7] The potential indications for BPM are a known mutation of *BRCA1* or *BRCA2* (or other susceptibility genes), strong family history (multiple first-degree relatives), or high-risk histology (atypical ductal hyperplasia [ADH], atypical lobular hyperplasia, or lobular carcinoma in situ [LCIS]).[7] There may also be an indication for BPM in other high-risk groups, such as women with non-*BRCA* hereditary breast cancer syndromes (e.g., Li–Fraumeni syndrome) or in women who received mantle radiation in the context of Hodgkin lymphoma treatment.[8]

### *Interest and satisfaction with prophylactic mastectomy*

The rate of contralateral prophylactic mastectomy (CPM) has been increasing in the United States and Canada in recent years.[9–12] The National Cancer Institute Surveillance, Epidemiology, and End Results (SEER) registry began tracking CPM in 1998. Between 1998 and 2003 the CPM rate increased 150% for patients with invasive breast cancer treated surgically.[11] Using the American College of Surgeons' National Cancer Database, Yao and colleagues[13] reported a comparable increase, where the rate of CPM increased from 0.7% in 1998 to 4.7% in 2007. However, since national cancer databases do not collect information on healthy women without breast cancer, it is challenging to accurately elicit the trends of BPM.[8] In their review of the New York state cancer registry, McLaughlin and colleagues[12] found that 1196 women without a diagnosis of cancer received BPM between 1995 and 2005; interestingly, the rate increased only slightly over the study period. Recent reviews addressing prophylactic mastectomies[8,9] note that the rate of BPM has likely increased secondary to increased awareness of genetic breast cancer, increased genetic testing and improvements in mastectomy and reconstruction techniques.

There is a growing body of literature documenting the long-term patient perspective on BPM and immediate reconstruction.[14–16] Geiger and colleagues[15] found that most (84%) women were satisfied at long-term follow-up after receiving BPM; there was no difference in quality of life between those who received BPM and those who did not in a risk-matched cohort. With an average follow-up of 14.5 years, Frost and colleagues[14] found that 70% of women were satisfied following BPM, with notable reductions in emotional concern about breast cancer developing and favourable psychological outcomes.

### *Timing for reconstruction after mastectomy*

Compared with therapeutic mastectomy in the context of active breast cancer, BPM is an elective procedure and gives the patient the option of the timing of reconstruction (delayed or immediate).[17] There was initially some resistance to immediate reconstruction, with some authors contending that patients who do not live with a mastectomy deformity are less likely to appreciate the esthetics of the reconstruction.[18,19] More recently, however, evidence has emerged that suggests that immediate reconstruction provides better esthetic results and greater patient satisfaction than delayed reconstruction.[20,21] With all other factors held constant, with more of the native breast skin available to envelope the reconstructed breast, immediate breast reconstruction typically yields superior esthetic results than delayed reconstruction.[20] Further, immediate breast reconstruction has been found to have materially lower incidence of psychological morbidity than delayed reconstruction.[18,22,23] The patient is able to wake from mastectomy surgery with a reconstructed breast mound and avoids having to live with a full mastectomy deformity. In their retrospective study, Al-Ghazal and colleagues[23] found that patients receiving immediate reconstruction had significantly greater body image and self-esteem and felt significantly less anxiety and depression than patients receiving delayed reconstruction. There are also cost benefits to immediate reconstruction. Khoo and colleagues[24] found the costs of delayed reconstruction to be 62% higher than those of immediate reconstruction. The lower overall costs were attributed to lower overall operating room (OR) time and fewer inpatient hospital days resulting from reducing the number of surgeries from 2 operations to 1.[24]

### *The rapid access prophylactic mastectomy and immediate reconstruction program*

Given the demonstrated cancer risk reduction and advantages of immediate reconstruction, there is a strong demand among high-risk breast cancer patients and carriers of the *BRCA1* and *BRCA2* mutations for BPM with immediate reconstruction. Unfortunately, given limited OR resources and active cancer taking priority, there can be long wait

times for patients who wish to undergo prophylactic procedures. Boyd and colleagues[25] found that women seeking reconstruction at the time of mastectomy with no active cancer (benign and high-risk) waited an average of 242 days, compared with 43 days for those with ductal carcinoma in situ and 40 days for those with invasive cancer.

Presently, there are no pan-Canadian wait time targets for cancer surgery; targets are mandated and monitored provincially.[26] In Ontario, for example, Cancer Care Ontario (CCO) sets targets based on the urgency of the malignancy; aggressive, invasive and indolent tumours have target wait times of 14, 28 and 84 days from readiness to treat to operation, respectively.[27] Further, the mandated wait time for elective general surgery procedures is 182 days.[28] As a result of the mandated cancer surgery wait times, patients without cancer often find themselves low on surgical wait lists and experience long wait times, which regularly exceed the 182-day target. The mandated cancer surgery wait time targets in Ontario have affected patients of other specialties who do not have cancer in a similar way. Cancer could develop in high-risk or *BRCA*+ women while they await elective procedures, thus a solution to this problem is necessary.

To address these challenges, a rapid access prophylactic mastectomy and immediate reconstruction (RAPMIR) practice model was created. Leveraging an outpatient hospital, the goal of the program was to increase access to BPM with immediate reconstruction among high-risk and *BRCA*+ women. The purpose of this study is to describe and evaluate this program with regards to access to care and surgeon efficiency.

## Methods

### *Rapid access prophylactic mastectomy and immediate reconstruction program*

Prior to the introduction of the RAPMIR program, patients who wished to undergo BPM with reconstruction were scheduled through a traditional model and triaged relative to the urgency of other surgical cancer cases. Scheduling was coordinated for surgical oncology and plastic surgery to perform a combined case at the main inpatient hospital. In this traditional model, prophylactic patients and patients with cancer were included on the same wait list for access to surgery. In November 2013, the RAPMIR practice model was implemented at a tertiary care outpatient hospital in Ottawa, Ont., Canada. In this new practice model, the prophylactic patients were included on an independent wait list, thus their wait times were no longer affected by those of patients with cancer.

The OR suite of the outpatient hospital consists of 5 ORs in a freestanding ambulatory centre with an annual case volume approaching 9000. The RAPMIR program runs 1 day each month and involves dedicated operating time for patients eligible for the program. To be eligible for treatment in the RAPMIR program a patient is required to be high-risk or a *BRCA1* or *BRCA2* carrier; to desire BPM with immediate, implant-based reconstruction (implant or tissue expander); and to be an acceptable candidate for day surgery (e.g., no comorbidities that would necessitate extended postanesthetic observation). Patients not eligible for inclusion or with confirmed surgery dates are managed through the traditional model.

To optimize scheduling, RAPMIR runs 2 ORs concurrently, with surgical oncology and plastic surgery teams alternating rooms (Fig. 1). In room 1, the surgical oncology team begins with the mastectomy portion of the first combined case. Once they complete the first BPM, they begin the second BPM in room 2 as the plastic surgery team begins reconstruction in room 1. Continuation of this pattern makes 3 BPMs with immediate reconstruction possible in 1 operative day (7:50–3:30). The surgical oncology and plastic surgery teams each complete 1–2 independent cases in the remaining time, for a daily total of 5–6 patients. The aforementioned timetable represents scheduling under optimal conditions; under circumstances

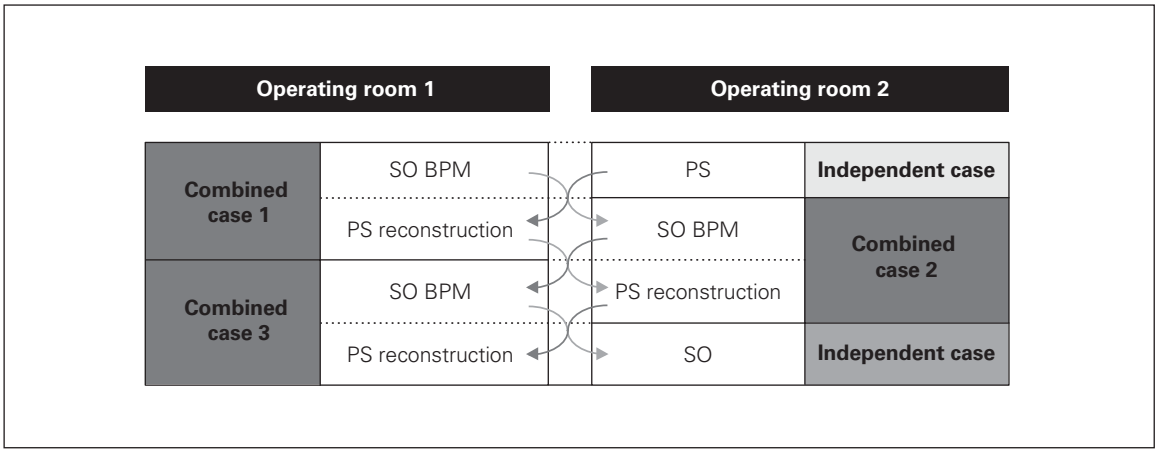


**Fig. 1.** Optimized operating room schedule of the rapid access prophylactic mastectomy and immediate reconstruction practice model. BPM = bilateral prophylactic mastectomy; PS = plastic surgery; SO = surgical oncology.

where there are fewer than 3 patients available for BPM, the remaining time is scheduled with alternative cases.

The postoperative protocol involves Steri-Srips (3M) left on the incisions until they fall off or until they are removed after a maximum of 2 weeks. Patients are instructed to shower within 24 h after surgery and to wear a supportive garment 24 h per day for 6 weeks. Drains are left in place until output is less than 30 mL/d for 2 consecutive days. Patients are prescribed a 7-day course of cephalexin (500 mg orally 4 times per day).

### *Retrospective chart review*

This study was performed at The Ottawa Hospital, a tertiary breast cancer centre in Ottawa, Ont., Canada, where approximately 850 breast cancers are treated annually. Following ethics approval, we initiated a retrospective chart review. The senior author's (K.U.B.) complete electronic medical records were reviewed for all patients who had received breast reconstruction between September 2012 and August 2014. Diagnostic and operative data were reviewed to identify all patients who were high-risk or had *BRCA* mutations and who received a prophylactic mastectomy. A patient was considered to be high-risk if she met 1 of the following inclusion criteria: 2 or more first- or second-degree relatives with breast or ovarian cancer, family history of breast cancer occurring before the age of 50 years, family history of both breast and ovarian cancer, or 1 or more relatives with 2 cancers (breast and ovarian cancer or 2 independent breast cancers). Patients with active cancer at the time of their mastectomy were excluded from the chart review.

We reviewed clinic notes for preoperative demographic data, and operative notes and anesthetic records were reviewed to document mastectomy type (nipple-sparing, skin-sparing), reconstruction (implant, tissue expander) and perioperative data. We retrieved referral and appointment dates from hospital records. All clinic notes following surgery were reviewed to document incidences of postoperative complications. The OR schedule for each day was retrieved to document case volume.

Patients were divided into 2 groups: those managed through the traditional model and those managed through the RAPMIR model. The RAPMIR group was composed of all patients who met the aforementioned RAPMIR program eligibility criteria after the program's initiation. The traditional group was composed of all patients who received BPM with immediate, implant-based reconstruction before the RAPMIR program's initiation and all patients who were not eligible for the RAPMIR program (e.g., medically unfit for day surgery) after the program's initiation.

### *Statistical analysis*

Assuming a type I error rate of 5% and a desired statistical power of 0.8, 13 participants were required in each group to show a 10% reduction in wait times[25] with the RAPMIR program.[29] We compared wait times (referral to consult, consult to surgery, referral to surgery) and surgeon productivity (case volume) between groups. Statistical analysis was performed using Pearson $\chi^2$, Fisher exact and independent *t* tests using SPSS software version 21.0 (IBM Corp).

## Results

The charts of 343 patients were included for review. A total of 29 patients were identified who were either high-risk or *BRCA*+ and who had prophylactic mastectomy with immediate reconstruction during the study period. During this time period, 5 different surgical oncologists performed the mastectomies, and 1 plastic surgeon performed all of the reconstructions. Sixteen patients were treated with the traditional model and 13 were treated through the RAPMIR model. Mean age for all patients at the date of surgery was 46.6 (range 26–67) years. Mean follow-up for all patients was 497.6 (234–1018) days. The baseline preoperative demographic data are shown in Table 1. The majority of patients were *BRCA*+ ($n$ = 27), with 1 patient in each group qualifying because of their high-risk status in the absence of a *BRCA* mutation ($n$ = 2). There were no significant differences in age, body mass index, weight, breast dimensions, or cup size between the RAPMIR and traditional groups. There were no active smokers in either group.

The perioperative and postoperative data are shown in Table 2. All patients had either a skin- or nipple-sparing mastectomy. The decision for nipple-sparing mastectomy was based on body habitus, ptosis and patient preference. Patients with large, ptotic breasts were considered ineligible for nipple-sparing mastectomy. When compared with nipple-sparing mastectomies, skin-sparing mastectomies were more common in the RAPMIR group (84.6%) than the traditional group (50%), but this difference was not significant. Both groups had comparable postoperative complications. The most common complication in both the traditional and the RAPMIR groups was cellulitis requiring treatment with antibiotics (25.0% and 23.1%, respectively). Of the patients with postoperative cellulitis, 2 (28.6%) had type 2 diabetes mellitus, both of whom were in the traditional group. One patient in the RAPMIR group required reoperation for a deflated tissue expander, whereas 4 patients in the traditional group required reoperation for tissue expander deflation ($n$ = 1), hematoma ($n$ = 1), skin flap necrosis ($n$ = 1), or seroma ($n$ = 1). There were no differences in the duration of surgery, mastectomy weight, implant size, estimated blood loss, postoperative complications, or rate of unplanned reoperation between the groups.

The total wait time from referral to surgery was 47% shorter for the RAPMIR group compared with the traditional group (165.4 v. 309.2 d). This difference was driven by a significantly shorter time from consult to surgery in

**Table 1. Preoperative patient demographic characteristics**

| Characteristic | Group; mean ± SD or no. (%) RAPMIR (*n* = 13) | Traditional (*n* = 16) | *p* value |
|---|---|---|---|
| Age at time of surgery, yr | 47.2 ± 12.0 | 46.1 ± 10.8 | 0.79* |
| Risk status | | | > 0.99† |
| *BRCA*+ | 12 (92.3) | 15 (83.8) | |
| High-risk | 1 (7.7) | 1 (6.2) | |
| Body mass index | 25.8 ± 4.4 | 27.0 ± 7.8 | 0.62* |
| Weight, kg | 72.1 ± 13.5 | 69.8 ± 17.2 | 0.70* |
| Type 2 diabetes mellitus | 0 (0) | 2 (12.5) | 0.49† |
| Sternal notch to nipple distance, cm | 24.7 ± 3.0 | 24.0 ± 3.4 | 0.56* |
| Nipple to inframammary fold distance, cm | 8.5 ± 2.7 | 8.6 ± 2.0 | 0.96* |
| Breast width, cm | 12.7 ± 1.2 | 12.4 ± 2.0 | 0.56* |
| Breast cup size | | | 0.96‡ |
| A | 1 (7.7) | 2 (12.5) | |
| B | 3 (23.1) | 5 (31.3) | |
| C | 3 (23.1) | 8 (50.0) | |
| D | 5 (38.5) | 0 (0) | |
| DD | 1 (7.7) | 1 (6.3) | |

RAPMIR = rapid access prophylactic mastectomy and immediate reconstruction; SD = standard deviation.
*Independent *t* test.
†Fisher exact test.
‡Pearson $\chi^2$ test.

**Table 2. Preoperative and perioperative patient characteristics**

| Characteristic | Group; no. (%) or mean ± SD RAPMIR (*n* = 13) | Traditional (*n* = 16) | *p* value |
|---|---|---|---|
| Type of mastectomy | | | 0.11† |
| Nipple-sparing | 2 (15.4) | 8 (50.0) | |
| Skin-sparing | 11 (84.6) | 8 (50.0) | |
| Mastectomy, g | 489.5 ± 323.5 | 404.1 ± 220.5 | 0.41* |
| Type of reconstruction | | | > 0.99† |
| Implant | 9 (69.2) | 10 (62.5) | |
| Tissue expander | 4 (30.8) | 6 (37.5) | |
| Acellular dermal matrix placement | | | 0.49† |
| AlloDerm placement | 13 (100) | 14 (87.5) | |
| No AlloDerm placement | 0 (0) | 2 (12.5) | |
| Implant size, g | 396.1 ± 133.4 | 362.0 ± 91.4 | 0.52* |
| Duration of surgery, min | 176.2 ± 40.5 | 166.8 ± 34.5 | 0.51* |
| Estimated blood loss, mL | 151.5 ± 46.3 | 118.8 ± 81.4 | 0.10* |
| Total postoperative complications | 5 (38.5) | 6 (37.5) | > 0.99† |
| Cellulitis (requiring treatment with antibiotics) | 3 (23.1) | 4 (25.0) | |
| Seroma | 2 (15.4) | 2 (12.5) | |
| Hematoma | 0 (0) | 1 (6.3) | |
| Implant or tissue expander deflation | 1 (7.7) | 1 (6.3) | |
| Nipple, T-junction, or flap necrosis | 1 (7.7) | 3 (18.8) | |
| Unplanned reoperation for complication | 1 (7.7) | 4 (25.0) | 0.34† |
| Seroma | 0 (0) | 1 (6.3) | |
| Hematoma | 0 (0) | 1 (6.3) | |
| Implant or tissue expander deflation | 1 (7.7) | 1 (6.3) | |
| Nipple, T-junction, or flap necrosis | 0 (0) | 1 (6.3) | |

RAPMIR = rapid access prophylactic mastectomy and immediate reconstruction; SD = standard deviation.
*Independent *t* test.
†Fisher exact test.

the RAPMIR group compared with the traditional group (127.4 v. 284.1 d), as there was no significant difference between the time from referral to consultation. The summary of patient wait times is shown in Table 3.

There were 14 operative days completed under the traditional model and 6 under the RAPMIR model. Compared with the traditional model, RAPMIR operative days had significantly greater daily case volumes for plastic surgery and surgical oncology as well as a larger total number of patients undergoing operations — plastic surgery case volume was 131% greater (1.6 v. 3.7), surgical oncology case volume was 36% greater (2.2 v. 3.0), and the total number of patients operated on was 54% greater (2.8 v. 4.3). The summary of surgeon productivity is shown in Table 4.

## Discussion

In patients with *BRCA1* or *BRCA2* mutations or a strong family history of breast cancer, BPM has a demonstrated cancer risk reduction[1–4] and favourable long-term psychological outcomes.[14–16] In the context of mastectomy, there is also a strong body of evidence indicating that compared with delayed reconstruction, immediate reconstruction provides better esthetic results,[20,21] greater patient satisfaction,[20,21] lower incidence of psychological morbidity,[18,22,23] and lower costs to the health care system.[24] Taken together, BPM with immediate reconstruction in *BRCA* carriers or high-risk patients is beneficial. However, with active cancer taking priority over prophylactic operations, significant wait times exist for patients to receive BPM with reconstruction.[25] The RAPMIR practice model was innovated at The Ottawa Hospital to improve patients' (high-risk or *BRCA*+) access to BPM with immediate reconstruction while concurrently optimizing the use of scarce OR resources.

The RAPMIR program leveraged 2 concurrently running ORs at an outpatient hospital 1 day each month with an independent wait list for the high-risk and *BRCA*+ women. The surgical oncology and plastic surgery teams moved between rooms in order to complete 3 combined BPMs with immediate reconstruction each operative day. The implementation of the program improved access to care for patients. Compared with the traditional approach, patients treated through the RAPMIR model had a 47% reduction in wait time; from referral to surgery RAPMIR patients had a mean wait time of 165.4 days compared with 309.2 days through the traditional model. Notably, implementation of the RAPMIR model decreased wait times to within the mandated CCO target of 182 days (Fig. 1).[28]

Wait times for BPM among patients without an active cancer diagnosis are not commonly reported. However, wait times in the context of active breast cancer form a meaningful point of comparison. In the United States, using the National Cancer Database, Liederbach and colleagues[30] reported on the wait times for breast surgery in 819 175 patients from 2003 to 2011. In 2011, the mean wait time for mastectomy and reconstruction was 42 days, which had increased materially from 33 days in 2003.[30] Less advanced staging was associated with increased wait times, with carcinoma in situ having the longest wait times.[30] Similarly, in a Canadian study of wait times for patients seeking breast reconstruction between 2001 and 2004, Boyd and colleagues[25] found mean wait times of 43 days and 40 days for ductal carcinoma in situ (DCIS) and invasive cancer pathology, respectively. They also reported a mean wait time of 242 days from

**Table 3. Patient wait times and surgeon productivity**

| Wait | Group; mean ± SD | | *p* value* |
|---|---|---|---|
| | RAPMIR (*n* = 13) | Traditional (*n* = 16) | |
| Time from referral to plastic surgery consultation, d | 38.2 ± 105.8 | 25.1 ± 36.4 | 0.65 |
| Time from plastic surgery consultation to surgery, d | 127.4 ± 82.1 | 284.1 ± 177.7 | 0.005 |
| Time from plastic surgery referral to surgery, d | 165.4 ± 144.8 | 309.2 ± 178.4 | 0.027 |

RAPMIR = rapid access prophylactic mastectomy and immediate reconstruction; SD = standard deviation.
*Independent *t* test

**Table 4. Surgeon productivity and patient throughout**

| Measure | Group; mean ± SD | | *p* value* |
|---|---|---|---|
| | RAPMIR (*n* = 6) | Traditional (*n* = 14) | |
| Operations/d (plastic surgery) | 3.7 ± 0.8 | 1.6 ± 0.6 | < 0.001 |
| Operations/d (surgical oncology) | 3.0 ± 0.0 | 2.2 ± 1.1 | 0.015 |
| No. of patients/d receiving BPM with immediate reconstruction | 2.3 ± 0.5 | 1.1 ± 0.3 | 0.001 |
| Total no. of patients operated/d, BPM and non-BPM ("throughput") | 4.3 ± 0.8 | 2.8 ± 0.8 | 0.003 |

BPM = bilateral prophylactic mastectomy; RAPMIR = rapid access prophylactic mastectomy and immediate reconstruction; SD = standard deviation.
*Independent *t* test.

referral to surgery for high-risk patients or benign disease, which offers perhaps the best benchmark to compare the wait times found in the present study.

The Fraser Institute is an independent research organization that has tracked wait times in Canada since 1988.[25] In a recent report by the Fraser Institute, the median wait time in Canada from general practitioner plastic surgery referral to treatment had increased from 14.2 weeks (99.4 d) in 1993 to 27.1 weeks (189.7 d) in 2014.[31] This wait time was composed of 12.2 weeks elapsing between general practitioner referral and plastic surgery consultation and 14.9 weeks elapsing between plastic surgery consultation and definitive treatment.[31] Interestingly, the 165.4-day wait time observed with the RAPMIR program is shorter than the 189.7-day median wait time reported by the Fraser Institute,[31] whereas the original 309.2-day wait of the traditional model was materially longer.

Implementation of the RAPMIR program also offered a significant improvement in surgeon productivity. The greater case volume from both surgeons naturally yielded a significant increase in the total number of patients undergoing operations each day (referred to as "throughput"), which rose by 54% under the RAPMIR model. These improvements in access and productivity were accomplished with no significant differences in complications or unplanned reoperations. Notably, the complication rates of 38.5% and 37.5% for the RAPMIR and the traditional groups, respectively, are comparable to the Stage I results of the BREASTrial, which reported an overall complication rate of 36.2% with the use of acellular dermal matrix in breast reconstruction.[32]

Throughput is an important metric in OR planning and monitoring.[33] Throughput, defined as the number of patients operated on over a given period of time, has implications for both patient wait times and health care costs. Throughput is inversely related to wait times,[33] whereby increasing the number of patients treated each day reduces wait times for all of the patients within the system.[34] Furthermore, given that a significant portion of OR costs are fixed costs,[35] increasing throughput has a beneficial impact on costs and resource utilization. As throughput increases in a system with significant fixed costs, the cost per surgical case is reduced as those fixed costs are spread across a greater number of operations. Simply put, more is accomplished with a comparable amount of resources. Taken together, the increased patient throughput of the RAPMIR program provides advantages to patients in the form of improved access as well as to the health care system through optimization of scarce OR resources.

### *Limitations*

There are some limitations to this study and its conclusions. First, it was a small retrospective cohort study designed to validate the impact of the RAPMIR program. The small size of each study group can be partially attributed to the low prevalence of *BRCA1* and *BRCA2* carriers, which is estimated at 0.07%–0.09% and 0.14%–0.22%, respectively.[36] Second, in the context of prophylactic procedures there are confounding factors impacting wait times. For example, patients from each group elected to delay surgery to accommodate their preference of date as opposed to having their operation at the earliest possible time. As this occurred to an uncertain degree in both groups, all patients who were eligible for study inclusion were included for analysis in an effort to minimize potential bias. Third, given the retrospective nature of the study design, patient satisfaction and quality of life metrics were not captured; this would be an interesting outcome measure to investigate in a future prospective study.

## Conclusion

Although it is early in the lifecycle of the RAPMIR program, the findings from this study suggest that a multidisciplinary model with optimized OR scheduling has the potential to improve access to BPM with immediate reconstruction for high-risk or *BRCA*+ patients. Importantly, the program accomplishes this in a manner that increases patient throughput and consequently optimizes scarce hospital resources and surgeon time. Although RAPMIR was originally implemented at an outpatient hospital, the basic structure and principles of the program would be suitable for implementation at either an inpatient or an outpatient facility for other non-cancer procedures.

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**Competing interests:** K. Usher Boyd is a paid consultant for LifeCell. In this role, she has received honoraria for speaking about the use of acellular dermal matrix and she has had expenses for travel covered to attend meetings regarding the same. This does not pose a conflict for the present study, as the products are not mentioned in the article, nor do they influence the topic. No other competing interests declared.

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