Estimated Impact of COVID-19 on Preventive Care Service Delivery: An Observational Cohort Study

Scott Laing (slain027@uottawa.ca)
University of Ottawa

Sharon Johnston
University of Ottawa

Research Article

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Abstract

Background: COVID-19 has caused significant healthcare service disruptions. Surgical procedure backlogs have been calculated but not those for other healthcare services. This study aims to estimate the backlog of key primary preventive care services caused by COVID-19.

Methods: This observational study assessed preventive care screening rates at three primary care clinics in Ottawa, Ontario from March to November 2020 using data from 22,685 electronic medical records. The change in cervical cancer, colorectal cancer, and type 2 diabetes screening rates were extrapolated using 2016 census data, estimating the volume of key services delayed by COVID-19 across Ontario and Canada.

Results: The mean percentage of patients appropriately screened for cervical cancer decreased by 7.5% (-0.3% to -14.7%; 95% CI), colorectal cancer decreased by 8.1% (-0.3% to -15.8%; 95% CI), and type 2 diabetes decreased by 4.5% (0.2% to -8.7%; 95% CI). Extrapolation estimated that Ontarians delayed 288,000 cervical cancer (11,000 to 556,000; 95% CI), 326,000 colorectal cancer (13,000 to 638,000; 95% CI), and 274,000 type 2 diabetes screenings (13,000 to 535,000; 95% CI). Extrapolation to the Canadian population nearly triples these numbers. Re-opening measures have not reversed these trends.

Interpretation: COVID-19 decreased the delivery of preventive care services, which may cause delayed diagnoses, increased mortality, and increased health care costs. Virtual care and reopening measures have not restored the provision of preventive care services. Electronic medical record data could be leveraged to improve screening via panel management. Additional, system-wide primary care and laboratory capacity will be needed to restore pre-COVID-19 screening rates.

Introduction

COVID-19 has strained our healthcare system and workforce in unprecedented ways and these effects are gradually being understood. Ministry of Health directives significantly reduced the volume of surgical procedures completed since March 2020. However, COVID-19’s impact on health care delivery extends beyond the operating room. Early data from Cancer Care Ontario, which has not been formally published, demonstrated large decreases in cancer screening from March to May 2020. Screening services are important for early cancer detection and treatment. Delays in cancer diagnosis and treatment significantly increase mortality rates. Much of this screening is performed by primary care providers in community clinics. The Ontario Ministry of Health has advised that community clinics limit in-person appointments, favoring virtual care assessments instead. Many preventive care services do not require in-person assessments and may still be provided through virtual care. However, many provincial screening programs were paused at the beginning of the pandemic. In Ontario, restrictions on colorectal cancer (CRC) screening with fecal immunochemical testing (FIT) lasted almost six months, lifting for high priority patients as of August 25, 2020.

While non-official reports indicate that cancer screening has decreased, there is still limited data that quantifies the volume of delayed preventive care services. Electronic medical record (EMR) data could help provide insight into this deficit. EMR’s provide a longitudinal history of patients’ health history and statuses, including provision of preventive care services. Primary care EMR data uniquely combines internally produced data with imported data from laboratories, imaging centers, specialists, and acute care. Accordingly, primary care EMR data may provide timely information on health outcomes and service delivery for health system planning and research purposes. This study utilized primary care EMR data to quantify the impact of COVID-19 on the delivery of preventive care services, namely cervical cancer, colorectal cancer (CRC), and type 2 diabetes mellitus (T2DM) screening. It is expected that the number of patients screened has decreased since COVID-19 restrictions began.

Methods

Preventive Care Data Sources

This was an observational cohort study. Data was extracted from three urban primary care clinics in Ottawa, Ontario, Canada. Two clinics were academic family health teams, and one was a community family health organization. All three clinics used PS Suites, which is provided by TELUS Health. A scheduled data export was developed using PS Suites’ built-in scheduled reports functionality. The scheduled report identified all active patient records and output each patient’s age, gender, past medical history, and select preventive care data in a tab delimited file. The scheduled reports ran every week from March 15, 2020 until November 29, 2020. Preventive care data necessary to determine compliance with the Canadian Task Force for Preventive Health Care’s (CTFPHC) recommendations were exported. The number of months since the last Papanicolaou smear was exported for cervical cancer screening and are represented by four data points. The number of months since the latest fecal occult blood test (FOBT), fecal immunochemical test (FIT), sigmoidoscopy, and colonoscopy were exported for CRC screening. Extrapolation estimated that Ontarians delayed 288,000 cervical cancer (11,000 to 556,000; 95% CI), 326,000 colorectal cancer (13,000 to 638,000; 95% CI), and 274,000 type 2 diabetes screenings (13,000 to 535,000; 95% CI). Extrapolation to the Canadian population nearly triples these numbers. Re-opening measures have not reversed these trends.

Determining The Impact On Screening Rates

Screening statuses for cervical cancer, CRC, and T2DM were determined from the exported EMR data. The analysis was completed using a Python 3.8 script, which analyzed the exported tab delimited files. The Python script determined each patient’s screening eligibility in agreement with the latest
CTFPHC’s recommendations for screening for cervical cancer(14), CRC(15), and T2DM(16) (Table 1). Since insufficient data was available to calculate the T2DM risk (CANRISK score) a minimum screening interval of 3 years was used instead. Patients considered high risk or ineligible for screening were excluded from the analysis. Full details of the inclusion and exclusion criteria algorithm are described in Appendix 1, 2, and 3.

After inclusion and exclusion criteria were applied, then each primary care providers’ patient panel was assessed, determining the percentage of patients that were up to date for cervical cancer, CRC, and T2DM screening. If screening was completed within the recommended interval, then that patient was counted as up to date for that screening maneuver.

\[
\text{Provider’s percentage of patients up to date} = \frac{\text{# of patients up to date}}{\text{# of patients eligible}} \times 100
\]

Once the percentage of patients up to date for the three screening tests was determined for each provider’s patient panel, then the mean percentage of patients up to date was determined for all providers. The mean percentage was determined to keep each provider’s screening rates confidential. The weekly mean percentages of patients up to date on preventive care screening were then graphed chronologically, including key dates from Ontario’s COVID-19 response(17). Finally, the change in mean percentage of patients up to date for screening between March 15, 2020 and November 29, 2020 was determined.

The impact of COVID-19 on in-person preventive care (cervical cancer screening), provincial screening programs (CRC screening), and screening that could be delivered through virtual care without restriction (T2DM screening) was estimated based on the change in mean from the beginning of the pandemic response(5).

Estimating The Preventive Care Deficits

The impact of COVID-19 on preventive care screening was extrapolated to estimate the Ontario and Canadian preventive care deficits. Census data from 2016(18) was used to estimate the number of people in Ontario and Canada that are due for cervical cancer, CRC, and T2DM screening.

Statistical Analysis

The 95% confidence intervals (CI) for the mean percentage of all providers’ patients that are up to date on cervical cancer, CRC, and T2DM screening were determined using a normal approximation method.

Ethics Approval

Patient consent was not required as was determined by the Bruyère Research Ethics Board at Bruyère Hospital in Ottawa, Ontario. REB Ethics Number: #M16-20-045. All required privacy and security measures were followed to maintain patient confidentiality.

Results

Practice Demographics

The demographics of the three clinics is presented in Table 2. Data was extracted from 22,685 active patients on a weekly basis across 29 providers. On November 29, 2020 6,754 were eligible for cervical cancer screening and 492 were excluded since they met high risk or exclusion criteria according to the CTFPHC’s guidelines as presented in Table 1. A total of 7,168 were eligible for colorectal cancer screening and 200 were excluded. Lastly, 10,933 met eligibility criteria for type 2 diabetes screening and 1,469 met the exclusion criteria. The numbers from March 15, 2020 were also reported for reference.

Impact Of Covid-19 On Mean Preventive Care Screening Rates

The period of data collection covered 38 weeks from March 15, 2020 until November 29, 2020. Two weeks of data were excluded due to errors in the scheduled data export causing incomplete data to be exported.

During the 38 weeks since March 15, 2020, the mean preventive care screening rates decreased for cervical cancer screening (Fig. 1), colorectal cancer screening (Fig. 2), and type 2 diabetes screening (Fig. 3). Cervical cancer screening rates decreased by 7.5% (-0.3% to -14.7%; 95% CI). The mean colorectal cancer screening rates decreased by 8.1% (-0.3% to -15.8%; 95% CI). The mean type 2 diabetes screening rates decreased by 4.5% (-0.2% to -8.7%; 95% CI).

A line of best fit was generated for each screening test and the slope indicated the weekly rate of change during this period. Cervical cancer screening rates decreased by 0.23% per week (Fig. 1). Colorectal cancer screening rates decreased by 0.25% per week (Fig. 2). Type 2 diabetes screening rates decreased by 0.13% per week (Fig. 3).
The Government of Ontario’s stages of gradual reopening are indicated for reference to demonstrate the impact of re-opening efforts on screening rates (Fig. 1, 2, and 3). For colorectal cancer screening, the date that FIT testing could be ordered was also shown (Fig. 2). None of the re-opening measures reversed the decreased screening trends across the three observed screening tests.

**Quantifying the Preventive Care Testing Needed to Return to Baseline Screening**

The number of patients among the 22,685 active patients at the three clinics requiring screening to return to baseline, low-risk screening rates were determined. A total of 505 (20 to 993; 95% CI) patients would need to have Papanicolaou smear testing (Table 3), 577 (22 to 1,133; 95% CI) would need colorectal cancer screening (Table 4), and 489 (21 to 951; 95% CI) would need type 2 diabetes screening (Table 5).

Extrapolating these numbers to Ontario’s population provided an estimated number of Ontarians requiring screening to return to pre-COVID-19, low-risk screening rates. Potentially 288,000 Ontarians (11,000 to 655,000; 95% CI) would need Papanicolaou smear testing (Table 3), 326,000 Ontarians (13,000 to 638,000; 95% CI) would need CRC screening (Table 4), and 274,000 Ontarians (13,000 to 535,000; 95% CI) would need T2DM screening (Table 5).

Similarly, extrapolation to the Canadian population provided an estimate of the number of Canadians needing screening to return to pre-COVID-19, low-risk screening rates. Potentially 745,000 Canadians (28,000 to 1,467,000; 95% CI) would need Papanicolaou smear testing (Table 3), 860,000 Canadians (35,000 to 1,685,000; 95% CI) would need CRC screening (Table 4), and 715,000 Canadians (34,000 to 1,396,000; 95% CI) would need T2DM screening (Table 5).

**Interpretation**

This observational cohort study estimated that hundreds of thousands of Ontarians may have delayed or been unable to access preventive care services since March 15, 2020. This trend has not reversed with re-opening measures implemented by the Government of Ontario. These observations align with unofficial reports from Ontario Health, which indicate that preventive care screening has decreased since March 2020. Extrapolation to the Canadian population estimates many thousands more have delayed preventive care since March 2020.

According to a review of preventive care services, only cervical cancer screening requires in-person assessments. Therefore, the finding that cervical cancer screening decreased since March 2020 is as expected, because Ministry of Health directives recommended avoiding in-person assessments. However, CRC screening may be offered through virtual care. The observed decrease in CRC screening is not explained by fewer in-person appointments. Instead, both laboratories pausing FIT kit distribution to reserve capacity for COVID-19 testing and the Ministry of Health recommendation to defer non-essential services have likely contributed to decreased CRC screening. This recommendation to defer healthcare services has likely reduced T2DM screening, as screening could be offered through virtual care without restrictions on hemoglobin A1c or fasting blood sugar testing. Similar findings of reduced utilization of healthcare services have been observed through fewer emergency department visits for heart failure, stroke, and pediatric assessments. Patient and provider clinical priorities may also shift from prevention and screening to management of active problems, like increased demand for mental healthcare services. Therefore, the findings of this study indicate that the reductions in preventive care service delivery are likely multifactorial.

Sustained reductions in preventive care are concerning since screening can detect early disease like cervical cancer, CRC, or T2DM. Accordingly, many cases of early disease are likely going undetected. Delayed diagnoses may have significant consequences as each four week delay in CRC treatment could increase mortality rates by 6 to 8%. This is supported by a recent model that predicted prolonged preventive care delays will cause higher cancer mortality and advanced disease at diagnosis. From a health system perspective, delayed cancer diagnoses may significantly increase cancer treatment costs. Prolonged undiagnosed and untreated T2DM is also expected to present problems since untreated T2DM increases the risk of cardiovascular disease mortality. Therefore, strategies to restore preventive care service delivery to pre-COVID-19 levels are essential. As COVID-19 restrictions persist and recur, the multifactorial patient, provider and health system factors impacting preventive care delivery need to be better understood and addressed.

This study has demonstrated that EMR data can be used to determine patients’ preventive care screening statuses. This automated function could be developed for other EMRs to generate monthly preventive care reports for providers. These reports could then be used for targeted preventive care delivery, prioritising in-person visits for those most overdue or needing tests that require in-person assessments. Additionally, point-of-care tools could support opportunistic preventive care delivery during visits for other reasons. The literature supports that digital solutions like EMR reminders combined with active panel management can improve screening rates. However, for these data to raise preventive care rates, system capacity must be improved as laboratories have only recently restored some capacity for screening test.

Another potential strategy has already been implemented by the Government of Ontario to address the surgical backlog, including cancer surgeries. This strategy involves investments in system capacity and providing financial incentives for health service delivery. Directing additional resources upstream to support additional time and planning to restore preventive care services could effectively boost screening rates and maintain early disease detection. This could help mitigate the anticipated increase in cancer mortality, later stage diagnoses, and increased health care costs.
Limitations

This study extrapolated data based on three clinics in Ottawa, a single urban centre in Ontario, Canada. Differences may exist between urban and rural preventive care service delivery and across Ontario. Additionally, the generalizability to the Canadian population could be impaired due to differences in local restrictions since Canada's healthcare systems are provincially run. This study also relies on high quality EMR data which may suffer from accuracy, completeness, and consistency issues(34). These challenges arose when developing the data export. Screening data was not consistently encoded following the same method, therefore multiple exported data points had to be amalgamated to improve data quality. Lastly, the impact of COVID-19 on T2DM screening may be underestimated since a 3 year interval was used despite guidelines recommended 1 to 3 years based on calculated risk scores.

Conclusions

This observational cohort study estimated that hundreds of thousands of Canadians may not have been screened for cervical cancer, CRC, and T2DM according to low-risk screening guidelines. Re-opening initiatives have not reversed the decrease in screening rates. Given the decreased screening, Canadians will likely be facing a surge of later stage cancer and diabetes diagnoses. Therefore, strategies like using EMR data to inform active panel management and directing additional resources to preventive care delivery and testing will be needed to reverse these trends and catchup on the hundreds of thousands of overdue tests.

| Screening Type       | Age (years) | Sex          | Interval (years) |
|----------------------|-------------|--------------|------------------|
| Cervical Cancer(14)  | 25 to 69    | Female       | 3                |
| Colorectal Cancer(15)| 50 to 74    | Female and Male | 2 (FOBT and FIT) |
|                      |             |              | 10 (sigmoidoscopy and colonoscopy) |
| Type 2 Diabetes(16)  | ≥ 40        | Female and Male | 3                |

Table 1

Summarized Canadian Task Force for Preventive Health Care's screening recommendations.

|                | Mar 15, 2020 | Nov 29, 2020 |
|----------------|--------------|--------------|
| Total Number of Patients | 22,648       | 22,685       |
| Total Number of Providers     | 29           | 29           |

Patient Demographics. Indicates the total number of patients and providers included in this study. The number of patients eligible for low-risk screening and excluded due to meeting the exclusion criteria (see Appendices for details) were also reported.

|                | Mar 15, 2020 | Nov 29, 2020 |
|----------------|--------------|--------------|
| Cervical Cancer Screening |               |              |
| Low Risk Eligible | 6,765        | 6,754        |
| Excluded          | 495          | 492          |
| Total             | 7,260        | 7,246        |
| Colon Cancer Screening |             |              |
| Low Risk Eligible | 7,170        | 7,168        |
| Excluded          | 201          | 200          |
| Total             | 7,371        | 7,368        |
| Diabetes Screening     |              |              |
| Low Risk Eligible | 10,897       | 10,993       |
| Excluded          | 1,474        | 1,469        |
| Total             | 12,371       | 12,402       |
Estimated Number of Patients Due for Cervical Cancer Screening. The number of females in the screening age range for cervical cancer screening were calculated from 2016 census data(18). The percentage of patients eligible for screening and due for screening to return to baseline were determined from the study clinics, then used to estimate the number of patients eligible for screening in Ontario and Canada. The lower confidence level (LCL) and upper confidence level (UCL) were also determined based on the study population. Estimations for Ontario and Canada were rounded to the nearest 1,000 patients.

| No. in Age Range | % Eligible for Screening | % Eligible for Screening | % Due for Screening (Baseline) | No. Due for Screening | LCL 95% of % Due for Screening | LCL No. Due for Screening | UCL 95% of % Due for Screening | UCL No. Due for Screening |
|------------------|--------------------------|----------------------------|--------------------------------|----------------------|------------------------------|---------------------------|-------------------------------|--------------------------|
| Study Clinics    | 7,246                    | 93.2%                      | 6,754                          | 7.5%                 | 505                          | 0.3%                       | 19                            | 14.7%                    | 990                      |
| Ontario          | 4,130,515                 | 93.2%                      | 3,850,000                      | 7.5%                 | 288,000                      | 0.3%                       | 11,000                        | 14.7%                    | 565,000                  |
| Canada           | 10,734,670                | 93.2%                      | 10,006,000                     | 7.5%                 | 748,000                      | 0.3%                       | 28,000                        | 14.7%                    | 1,467,000                |

Estimated Number of Patients Due for Colorectal Cancer Screening. The number of patients in the screening age range for colorectal cancer screening were calculated from 2016 census data(18). The percentage of patients eligible for screening and due for screening to return to baseline were determined from the study clinics, then used to estimate the number of patients eligible for screening in Ontario and Canada. The lower confidence level (LCL) and upper confidence level (UCL) were also determined based on the study population. Estimations for Ontario and Canada were rounded to the nearest 1,000 patients.

| No. in Age Range | % Eligible for Screening | % Eligible for Screening | % Due for Screening (Baseline) | No. Due for Screening | LCL 95% of % Due for Screening | LCL No. Due for Screening | UCL 95% of % Due for Screening | UCL No. Due for Screening |
|------------------|--------------------------|----------------------------|--------------------------------|----------------------|------------------------------|---------------------------|-------------------------------|--------------------------|
| Study Clinics    | 7,368                    | 97.3%                      | 7,168                          | 8.1%                 | 577                          | 0.3%                       | 24                            | 15.8%                    | 1,130                    |
| Ontario          | 4,158,340                 | 97.3%                      | 4,045,000                      | 8.1%                 | 326,000                      | 0.3%                       | 13,000                        | 15.8%                    | 638,000                  |
| Canada           | 10,982,180                | 97.3%                      | 10,006,000                     | 8.1%                 | 860,000                      | 0.3%                       | 35,000                        | 15.8%                    | 1,685,000                |

Estimated Number of Patients Due for Type 2 Diabetes Screening. The number of patients in the screening age range for type 2 diabetes were calculated from 2016 census data(18). The percentage of patients eligible for screening and due for screening to return to baseline were determined from the study clinics, then used to estimate the number of patients eligible for screening in Ontario and Canada. The lower confidence level (LCL) and upper confidence level (UCL) were also determined based on the study population. Estimations for Ontario and Canada were rounded to the nearest 1,000 patients.

| No. in Age Range | % Eligible for Screening | % Eligible for Screening | % Due for Screening (Baseline) | No. Due for Screening | LCL 95% of % Due for Screening | LCL No. Due for Screening | UCL 95% of % Due for Screening | UCL No. Due for Screening |
|------------------|--------------------------|----------------------------|--------------------------------|----------------------|------------------------------|---------------------------|-------------------------------|--------------------------|
| Study Clinics    | 12,402                   | 88.2%                      | 10,933                          | 4.5%                 | 489                          | 0.2%                       | 23                            | 8.7%                     | 954                      |
| Ontario          | 6,952,870                 | 88.2%                      | 6,129,000                       | 4.5%                 | 274,000                      | 0.2%                       | 13,000                        | 8.7%                     | 535,000                  |
| Canada           | 18,139,570                | 88.2%                      | 15,991,000                      | 4.5%                 | 714,000                      | 0.2%                       | 34,000                        | 8.7%                     | 1,396,000                |

Declarations

Ethics Approval and Consent to Participate

This study was approved by Bruyère Research Ethics Board at Bruyère Hospital in Ottawa, Ontario. REB Ethics Number: #M16-20-045.

Consent for Publication

Patient consent was not required as determined by the Bruyère Research Ethics Board at Bruyère Hospital in Ottawa, Ontario. REB Ethics Number: #M16-20-045. All required privacy and security measures were followed.

Availability of Data and Materials

The datasets generated and/or analysed during the current study are not publicly available due patient confidentiality and privacy. Filtered data may be available from the corresponding author on reasonable request and review by Bruyère Research Ethics Board.

Competing Interests

The authors declare that they have no competing interests.

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Authors’ Contributions

SL collected, analyzed, and interpreted the data, including development of the scripts that performed the analysis. Both SL and SJ contributed to the conception and design of the study, drafted and revised the final manuscript.

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Figures

![Cervical Cancer Screening Rates](image-url)

Figure 1

Cervical Cancer Screening Rates. Shows the mean percentage (percentage screened ± SD) of eligible patients up to date for cervical cancer screening each week (n = 6,765 March 15, 2020; n = 6,754 November 29, 2020). For reference the lockdown and re-opening stages have been identified. Lockdown = March 20, 2020, Stage 2 = June 12, 2020, Stage 3 = July 17, 2020, and Modified Stage 2 = October 13, 2020.
Figure 2

Colorectal Cancer Screening Rates. Shows the mean percentage (percentage screened ± SD) of eligible patients up to date for colorectal cancer screening each week (n = 7,170 March 15, 2020; n = 7,168 November 29, 2020). For reference the lockdown and re-opening stages and when FIT testing could be ordered again have been identified. Lockdown = March 20, 2020, Stage 2 = June 12, 2020, Stage 3 = July 17, 2020, FIT Resumes = August 25, 2020, and Modified Stage 2 = October 13, 2020.

Overall change = -8.1% (-0.3% to -15.8%; 95% CI)
Rate of change: -0.25% per week

Figure 3

Type 2 Diabetes Screening Rates. Shows the mean percentage (percentage screened ± SD) of eligible patients up to date for cervical cancer screening each week (n = 10,897 on March 15, 2020; n = 10,933 on November 29, 2020). For reference the lockdown and re-opening stages have been identified. Lockdown = March 20, 2020, Stage 2 = June 12, 2020, Stage 3 = July 17, 2020, and Modified Stage 2 = October 13, 2020.

Overall change = -4.5% (-0.2% to -8.7%; 95% CI)
Rate of change: -0.13% per week

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- S1CervicalCancerInclusionandExclusionCriteria.docx
- S2ColonCancerInclusionandExclusionCriteria.docx
- S3T2DMInclusionandExclusionCriteria.docx
- S4PreventiveCareDataPointExtractedFromDatabase.docx