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A more accurate approach to define abortion cohorts using linked administrative data: an application to Ontario, Canada

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Abstract

Background

The shifting landscape of abortion care from a hospital-only to a distributed service including primary care has implications for how to identify abortion cohorts for research and surveillance. The objectives of this study were to 1) create an improved approach to define abortion cohorts using linked administrative data sets and 2) evaluate the performance of this approach for abortion surveillance compared with standard approaches.

Methods

We applied four principles to identify induced abortion cohorts when some services are delivered beyond hospital settings; 1) exclude early pregnancy losses and postpartum procedures; 2) use multiple data sources; 3) define episodes of care; 4) apply a hierarchical algorithm to determine abortion date to a population-based cohort of all abortion events in Ontario (Canada) from January 1, 2018-March 15, 2020. We calculated risk differences (RD, with 95% confidence intervals) comparing the proportion of medication vs. surgical, first vs. second trimester, and complication incidence applying these principles vs. standard approaches.

Results

Hospital-only data (versus multiple data sources) underestimated the frequency of medication abortion (16.1% vs. 31.4%; RD −15.3% [−14.3, −16.3]) and first-trimester abortion (82.1% vs. 94.5%; RD −12.8 [−11.4, 13.4]) and overestimated incidence of abortion complication (2.9% vs. 0.69%; RD 2.2% [1.8, 2.7]). An unlinked (versus linked) approach underestimated the frequency of abortion complications (0.19% vs 0.69%, −RD 0.50% [−0.44–−0.56]). Including (versus excluding) abortions following early pregnancy loss or delivery events increased the estimated incidence of abortion complications (1.29% vs. 0.69%, RD 0.60% [0.51–0.69].

Conclusion

New methods are required to accurately identify abortion cohorts for surveillance or research. When legal or regulatory approaches to medication abortion evolve to enable abortion in primary care or office-based settings, hospital-based surveillance systems will become incomplete and biased; to continue valid and complete abortion surveillance, methods must be adjusted to ensure complete capture of procedures across all settings.

Keywords

abortion surveillance; abortion cohorts; linked administrative data; cohort methods

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Introduction

Accurate health service utilization and safety surveillance data are essential for health policy and for decision-makers to plan, evaluate, and improve health service delivery, access, and health outcomes. Abortion frequency, access, and outcomes are key indicators of a jurisdiction's reproductive population health, necessary for understanding access to family planning services and women's health [1, 2]. Monitoring the incidence of pregnancy, abortion, and birth is important to understand population trends in fertility and the ability for individuals and families to achieve their reproductive goals [2, 3]. Accurate tracking of abortion frequency enables surveillance of abortion safety, a key component of reproductive population health [3].

The centrality of sexual and reproductive health service access for reproductive population health and gender equity is demonstrated by its inclusion as target 5.6 in the United Nation's Sustainable Development Goal 5 "Achieve gender equality and empower all women and girls" [4]. Abortion, however, is unlike other reproductive health outcomes (e.g., births and infant deaths [5], severe maternal morbidity [6]) in that it is illegal in some settings and stigmatized in others. This often impacts the quality of abortion surveillance data [2].

Over the past four decades, abortion practice has changed substantially across the globe with the advent of mifepristone, a highly effective medication abortion drug. First synthesized in 1980, mifepristone was approved for use for induced abortion in 1988 in France, 1991 in Great Britain, 1992 in Sweden, 2000 in the United States and 2015 in Canada [7, 8]. Before mifepristone availability, the vast majority (>95%) of abortions in the first trimester (i.e., less than 14 weeks of gestational age) were provided as surgical procedures, via vacuum or suction aspiration [9]. Although the rate of mifepristone uptake following regulatory approval has varied substantially by country [7, 10]; in 2018, mifepristone medication abortion accounted for more than a quarter of abortions in Canada [11] and nearly 40% of abortions in the United States [12]. In 2020, nearly 75% of abortions in England and Wales [13], and over 80% of abortions in Sweden [14] were provided using mifepristone. In most settings, regulatory restrictions on mifepristone provision, such as observed dosing, only-by-physician dispensing, or restrictions on the location where an abortion may be performed, have resulted in mifepristone medication abortion delivery in purpose-specific abortion clinics, most usually those that also provide surgical abortion services. However, in some settings (e.g., Canada) [15] mifepristone is now regulated as a normal prescription medication (without medication-specific regulatory limits), and as a result medication abortion provision frequently occurs in distributed, generalist office-based and primary care settings [16].

In some countries, induced abortion surveillance historically relied on single data sources [17]. This approach supports valid surveillance if the single source captures all abortions. For example, in Canada, abortion care was restricted to hospital-based provision from decriminalization in 1969 until a Supreme Court decision removed the hospital-based abortion service requirement, which facilitated abortion provision outside hospital settings, in 1988 [15, 18]. Thus, hospital-based abortion surveillance data provided accurate measures of abortion frequency, characteristics, and complications until 1988, after which multiple data sources were required for accurate surveillance [15, 17, 19]. In the United States, induced abortion surveillance is conducted by the Centres for Disease Control and Prevention based on voluntary state-level reporting (33 of 50 states report) with limited detail or follow-up and no individual-level data available [20]. In contrast, in many countries, such as Finland, England, Scotland, and Wales, physicians providing abortion services must report each abortion directly to a national registry of induced abortions using a standardized form [21]. Creating abortion cohorts using multiple data sources requires careful consideration of situations in which a single abortion event may generate multiple encounters in various data sets. For example, an uncomplicated medication abortion would generate both a practitioner billing and pharmacist dispensation records, while an abortion resulting in a complication may also follow-up encounters in office-based or hospital settings.

The shifting landscape of abortion care provision has implications for how we capture and analyze these services. In settings where abortion care has expanded from exclusively hospital-based provision of surgical abortion to distributed provision of both surgical and medication abortion in a range of community healthcare and office settings, surveillance using hospital-only data will no longer capture all abortion events. In these settings, abortion surveillance is more complex, potentially requiring linkages across multiple data sources to achieve complete capture of the number of abortions, abortion characteristics, and abortion complications (which may not be tracked using the same data sources). Thus, abortion surveillance and abortion cohorts used for research and evaluation must consider the local health services and systems context to ensure complete capture of abortion events and outcomes. This is particularly important to understand trends over time and evaluate the impact of how changes in health system and service provision models may impact access, outcomes, and safety.

The objectives of this study were to 1) create a rigorous approach to define abortion cohorts using linked administrative data sets and 2) evaluate the performance of these methods for abortion surveillance compared with a simpler approach.

Methods

Our interdisciplinary team of clinicians, health services researchers, epidemiologists, and linked health administrative data experts conducted this study. We identified and applied four principles to develop a rigorous approach for defining induced abortion cohorts when surgical and medication abortion services are distributed across multiple practice settings and when a single abortion may generate several health service encounters:

1. *Principle 1: Exclude early pregnancy losses and postpartum treatment.* This differentiates between the need for uterine evacuation for reasons other than abortion, such as can occur with early pregnancy loss or postpartum procedures (e.g., managing postpartum hemorrhage). In a single pregnancy, an abortion cannot co-occur with an early pregnancy loss or a delivery. Because reimbursement structures may incentivize billing for abortion when providing care for early

pregnancy loss or performing postpartum procedures, any abortion events co-occurring with codes for early pregnancy loss or postpartum management should be excluded from abortion cohorts.

2. *Principle 2: Use multiple linked data sources* to capture comprehensively all relevant encounters: practitioner billing/claims records coded using fee and diagnostic codes; inpatient and ambulatory care hospital records (using intervention and diagnostic codes); and prescription records for mifepristone. These databases must be linkable at the record-level.

3. *Principle 3: Define episodes of care* and identify all records within an episode that are considered part of a single abortion episode. This prevents double-counting for abortions that require multiple encounters. There is uncertainty in optimal episode length, with some suggesting a follow-up period as short as one to three weeks [22], with four [23] or six [24, 25] weeks used most often by researchers.

4. *Principle 4: Apply a hierarchical algorithm to determine the abortion date* when multiple records occur during an abortion episode. This type of algorithm requires clinical expertise. It should identify any abortion-related service occurring before or after the index abortion event but during the (6 week) abortion episode as a follow-up to the index event. It must be able to distinguish routine or complication-related follow-up care from a subsequent abortion event.

We applied these principles to construct an abortion cohort using Ontario's linked, population-based administrative health data from January 1, 2018 – March 15, 2020. We chose this study period to exclude the first year of mifepristone medical abortion availability in Canada due to the rapid and multiple changes to medication abortion regulatory restrictions at that time [16] and to exclude abortions occurring after the declaration of the COVID-19 pandemic [26].

Our data included all records from practitioner encounters from the Ontario Health Insurance Program (OHIP billing/reimbursement records), hospitalization records from the Discharge Abstract Database (inpatient) and the National Ambulatory Care Reporting System (outpatient ambulatory clinics, subdivided as emergency department visits or ambulatory care visits), and outpatient mifepristone prescription dispensations from the Ontario Drug Benefit database (ODB). We accessed these data through Ontario's health administrative data warehouse (ICES). These data sets are created through the provision of health care through Ontario's provincial single-payer health insurance program which covers all Ontario residents, excluding newcomers to Ontario that have not yet achieved residency status (3-month waiting period) or for non-residents accessing health care in Ontario. We linked across databases using the "ICES key number", an encoded version of the Ontario Health Insurance Program number assigned to individuals covered by provincial health insurance, created by ICES. Linkage using this key number is routine in analyses using Ontario's health administrative data. As this number is directly derived from individual identifiers, duplicates or false positive linkages are not a concern. Billing/reimbursement records include fee codes for each encounter coupled with a diagnostic code from the International Classification of Disease Version 9 (ICD-9) coding system. Hospitalization records include intervention codes from the Canadian Classification of Interventions coding system and diagnostic codes from the International Classification of Disease Version 10-CA (ICD-10-CA) coding system.

We applied the four principles to these data sets to create a cohort of abortions as follows: After identifying all records with an abortion billing, diagnostic, or prescription code from these databases, we excluded records with simultaneous codes for clinical events with similar treatment or cascades of care (Principle 1). At the record level, we linked across datasets using the individual identifier to create unique abortion identifiers (Principle 2). We defined episodes of care such that any event within 6 weeks of the first event was considered part of the same abortion episode with the first event starting the episode (Principle 3). Finally, for those records with multiple abortion events, we identified which event was the most likely abortion date using a hierarchical approach to start the abortion episode (e.g., first encounter vs. prescription dispensation vs. post-abortion management) through consultation with clinician partners (Principle 4).

To evaluate the impact of applying these methods, we identified the resulting number of abortions with and without each principle in place and compared the frequency of abortion characteristics with and without each principle using χ^2 tests and risk differences (RD, with 95% confidence intervals). We examined incidences of the following abortion characteristics: percent medication vs. surgical, percent first ($<$14 completed weeks of gestational age) vs. second or third trimester ($\geq$14 weeks), and the incidence of abortion complications (including infection, hemorrhage, embolism, shock, metabolic disorders, renal failure, damage to pelvic organs, other venous complications, and other), all estimated with 95% confidence intervals.

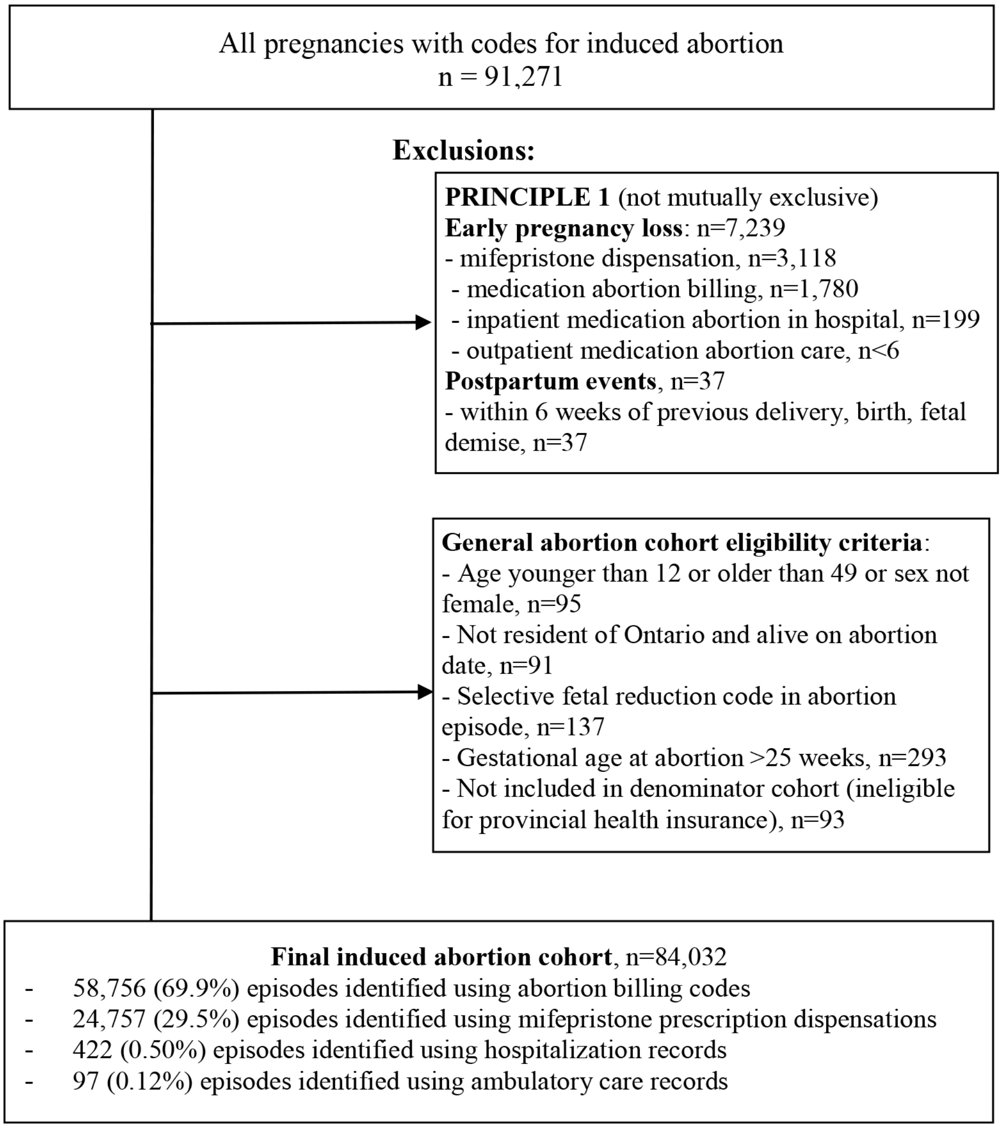
Results

Applying each of these principles to a population-based cohort of all abortions in Ontario, Canada from January 1, 2018 – March 15, 2020 using linked data from multiple sources yielded a cohort of 84,032 abortions (see complete cohort derivation in Figure 1).

Of these, 26,414 (31.4%, 95% CI 31.1–31.8) were medication abortions, 57,581 (68.5%, 68.2–68.8) were surgical abortions, and 39 (0.1%, 0.0-0.1) were unclassified/unknown method. Nearly all ($n = 79,385$, 94.5% [94.3–94.6]) were first trimester abortions, while 5.1% (5.0–5.3) occurred in the second or third trimester, and 0.4% (0.4–0.5) had unknown/missing gestational age. The incidence of abortion complications was 0.69% (0.63–0.74; $n = 578$).

We found that including records with codes for abortion that also had codes for early pregnancy loss or postpartum events (versus excluding these, Principle 1) yielded a larger abortion cohort (91,174 vs. 84,032) and overestimated medication abortion frequency (32.6% vs. 31.4%, RD 1.2%[0.76–1.6], $p < 0.001$). In addition, including records with early pregnancy loss or postpartum treatment codes

Figure 1: Study population derivation: induced abortion episodes identified by linking physician billing, hospitalization, ambulatory care clinic, and prescription records in Ontario, Canada, Jan 2018 – Mar 2020



underestimated first trimester abortion frequency (93.9% vs. 94.5%, RD −0.60[−0.82–0.38], $p < 0.001$) and overestimated the incidence of abortion complications (1.29% vs. 0.69%, RD 0.60%[0.51–0.69], $p < 0.001$), as shown in Table 1.

Table 2 compares the abortion cohort identified using multiple data sources (linked inpatient and ambulatory hospital records, practitioner billing records, outpatient prescription dispensation records) with cohorts identified using a single source (only inpatient/outpatient hospital records or only billing/claims records). We found that multiple data sources identified 77,994 more abortions than hospital-only records and 3,751 more than practitioner billing records only. Hospital-only data underestimated the frequency of medication abortion (16.1% vs. 31.4%; risk difference (RD) −15.3% [−14.3, −16.3], $p < 0.001$) and first-trimester abortion (82.1% vs. 94.5%; RD −12.8 [−11.4, −13.4], $p < 0.001$) and overestimated the incidence of abortion complications (2.9% vs. 0.69%; RD 2.2% [1.8, 2.7] $p < 0.001$). The cohort identified using billing data underestimated medication abortion frequency (26.2% vs 31.4%, RD −5.2% [−10.4%, 0.0], $p < 0.001$), underestimated abortion complication frequency (0.61% vs 0.69%, RD −0.08 [0.0, −0.16], $p < 0.001$) and yielded similar first trimester abortion frequency (94.9% vs 94.5%, RD 0.4% [0.18, 0.62], $p = 0.933$) compared with the multiple linked data source approach.

In our comparison of an episodic approach versus an unlinked approach considering each abortion event as a separate abortion (Principle 3, Table 3), we found that the unlinked approach overestimated the number of abortions (99,965 vs. 84,032) and overestimated the frequency of medication abortion (37.2% vs. 31.4%, RD 5.8%[5.4–6.2], $p < 0.001$). The unlinked (versus episodic) approach accurately estimated the frequency of first trimester abortion (94.5% vs. 94.4%, $p = 0.351$), but underestimated the frequency of abortion complications (0.19% vs 0.69%, -RD 0.50%[−0.44–−0.56], $p < 0.001$).

In Table 4, we show the impact of using a hierarchical approach to define the abortion date (based on line-level clinical information) with a simpler 'first event is abortion'

Table 1: Impact of excluding vs. including early pregnancy loss and postpartum events (Principle 1) to define abortion cohorts on the number and characteristics of abortions identified

	Excluding all early pregnancy loss and postpartum events (novel approach)	Including early pregnancy loss and postpartum events		
Number of abortions	84,032		91,174	
	% (95% CI)	% (95% CI)	difference (95% CI)	p-value
Medication abortion	31.4% (31.1, 31.8)	32.6% (32.3, 32.9)	1.2% (0.76, 1.6)	<0.001
First trimester abortion	94.5% (94.3, 94.6)	93.9% (93.7, 94.0)	−0.60% (−0.38, 0.82)	<0.001
Abortion complications	0.69% (0.63, 0.74)	1.29% (1.21, 1.36)	0.60% (−0.51, 0.69)	<0.001

Table 2: Impact of using multiple data sources vs. single data sources (Principle 2) to define abortion cohorts on the number and characteristics of abortions identified

	Multiple linked data sources (novel approach)	Hospital data only (inpatient and outpatient)			Billing data only		
Number of abortions	84,032	6,038			80,281		
	% (95% CI)	% (95% CI)	difference (95% CI)	p-value	% (95% CI)	difference % (95% CI)	p-value
Medication abortion	31.4% (31.1–31.8)	16.1% (15.2, 17.1)	−15.3% (−14.3, −16.3)	$p < 0.001$	26.2% (25.9, 26.5)	−5.2% (0.0, −10.4%)	$p < 0.001$
First trimester abortion	94.5% (94.3–94.6)	82.1% (81.1, 83.0)	−12.4% (−11.4, −13.4)	$p < 0.001$	94.9% (94.8, 95.1)	0.4% (0.18, 0.62)	$p = 0.933$
Abortion complications	0.69% (0.63–0.74)	2.9% (2.5, 3.3)	2.2% (1.8, 2.7)	$p < 0.001$	0.61% (0.56, 0.67)	−0.08% (−0.0, −0.16)	$p < 0.001$

Table 3: Impact of using episodic vs. standard unlinked approach (Principle 3) to define abortion cohorts on the number and characteristics of abortions identified

	Episodic (novel) approach	Standard unlinked approach		
Number of abortions	84,032		99,965	
	% (95% CI)	% (95% CI)	difference (95% CI)	p-value
Medication abortion	31.4% (31.1–31.8)	37.2% (36.9, 37.5)	5.8% (5.4, 6.2)	$p < 0.001$
First trimester abortion	94.5% (94.3–94.6)	94.4% (94.3, 94.6)	−0.1% (−0.11, 0.31)	$p = 0.351$
Abortion complications	0.69% (0.63–0.74)	0.19% (0.16, 0.21)	−0.50% (−0.44, −0.56)	$p < 0.001$

Table 4: Impact of using hierarchical vs. first event is abortion approach (Principle 4) to define abortion date when creating abortion cohorts on the number and characteristics of abortions identified

	Hierarchical approach (novel approach)	First event is abortion approach		
Number of abortions	84,032		84,328	
	% (95% CI)	% (95% CI)	difference (95% CI)	p-value
Medication abortion	31.4% (31.1, 31.8)	31.7% (31.4, 32.0)	0.3% (−0.14, 0.74)	$p = 0.185$
First trimester abortion	94.5% (94.3, 94.6)	94.5% (94.34, 94.65)	0.0% (−0.22, 0.22)	$p = 1.0$
Abortion complications	0.69% (0.63, 0.74)	0.66% (0.61, 0.72)	−0.03% (−0.05, 0.11)	$p = 0.452$

approach. These approaches yielded nearly identical abortion cohorts (84,328 vs. 84,032 abortions) and similar estimates of medication abortion frequency (31.7% vs. 31.4%, $p = 0.185$), first trimester abortion frequency (94.5% vs. 94.5%, $p = 1.0$), and abortion complications (0.66% vs 0.69%, $p = 0.452$).

Discussion

In this study, we compared the number of abortions identified and key abortion characteristics (abortion method, trimester, and complication incidence) using standard methods with refined methods that applied four key principles to define abortion cohorts. This analysis proposes a conceptual framework to guide abortion surveillance and abortion cohort creation across jurisdictions when medication abortion becomes more frequent and/or when abortion services move from single or uniform service delivery settings to distributed practice models.

We found that the number of abortions identified, abortion type, and trimester of care were most impacted by number and type of data sources used, while abortion complication incidence was differentially impacted by number and type of data sources used, linkage across events for the same abortion, and inclusion of procedures following delivery or early pregnancy loss as an abortion procedure.

In particular, using hospital-only data dramatically underestimated the number of abortions identified, while using billing-only data only slightly underestimated the number of abortions. On the other hand, using an unlinked (vs episodic) approach and failing to exclude procedures following a recent delivery or early pregnancy loss both somewhat overestimated the number of abortions. Abortion type was most frequently misclassified (underestimating the proportion of medication abortions) with hospital-only data; similarly, the proportion that were medication abortions was slightly underestimated with billing-only data, and slightly overestimated when postpartum and pregnancy loss management procedures were not excluded. Using a hierarchical approach to determine the abortion event date (compared with using the first abortion event as the anchor date in every instance) had little impact on number of abortions identified or abortion characteristics.

Each methodological approach differentially impacted estimates of abortion complication incidence. Using hospital-only data and retaining abortion procedures following delivery or early pregnancy loss both overestimated the frequency of complications more than two-fold, while complication frequency with an unlinked approach was less than a third of that found using our proposed linked approach.

When local legal and practice regulations evolve to allow medication abortion provision outside hospital settings, selection or continuation of hospital-based surveillance will underestimate the number of abortions, overestimate the proportion of surgical abortions, and will systematically capture more complex abortion cases occurring at later gestational ages. This type of selection process has previously been demonstrated to induce selection bias [27, 28]; hospital-only abortion surveillance will overestimate the frequency of second trimester and surgical abortion (relative to first trimester medication abortion) and will overestimate the risk of abortion complications [29–37].

This change in methods to define induced abortion cohorts using administrative data mirrors other clinical practice contexts in which a treatment moved from a single service delivery model within a single setting to multiple delivery models provided in distributed settings [38–41]. Unlike these clinical areas, induced abortion practice, surveillance, and research are challenged with a historical context of legal and regulatory restrictions which have impeded access to the appropriate range of World Health Organization supported reproductive healthcare options [42–45].

This analysis demonstrates that these four principles are robust and will improve the accuracy of abortion surveillance across a range of health systems that support medication abortion in distributed practice settings [1–3]. Adopting this improved approach for abortion surveillance and creation of abortion cohorts for research purposes will become more important as health policy makers, systems, and service decision makers, and advocates struggle to understand the equitable distribution and safety of abortion services under a growing range of models of care [37, 46–49]. For example, as medication abortion becomes more frequent, hospital-only surveillance systems will draw qualitatively incorrect conclusions about the impact of this practice change on abortion safety.

The application and implementation of these principles must be adapted to local conditions and contexts; however, these underlying principles are generalizable to contexts in which induced abortion practice is distributed across systems and settings. The importance of excluding abortion events that co-occur with early pregnancy losses or postpartum treatment is important for creating valid abortion cohorts in all countries or jurisdictions, and particularly for reporting the incidence of abortion complications or adverse events. We expect that the approach we outlined to create valid abortion cohorts using multiple data sets is generalizable to any context where abortions occur in distributed practice settings (i.e., not restricted to hospital settings or to a defined number of purpose-specific abortion clinics). Our analysis may not be replicable in jurisdictions that do not enable linkages of health data across health care settings or where mifepristone is available online; in these jurisdictions it may not be possible to create valid abortion cohorts. Our findings indicate that universal health system payment, service, and outpatient prescription records are needed to accurately monitor abortion frequency, characteristics, and outcomes. When this is not feasible, any abortion surveillance or research activities should be transparent regarding the impact of these data set limitations on abortion frequency, characteristics, and complication incidence. Our results may be useful to estimate the potential direction and magnitude of bias induced by these data set limitations.

Conclusion

In settings where legal or regulatory approaches to medication abortion evolve to enable abortion provision in primary care or office-based settings, surveillance systems that rely on standard reporting by institutions will become incomplete and biased. For valid and complete abortion surveillance to continue when abortion practice disseminates to wider settings, methods must be overhauled to ensure complete capture of procedures across all settings. In this paper, we provide a conceptual framework to guide this process across jurisdictions.

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Ethics statement

Ethics approval for this study was granted by the University of British Columbia research ethics board (H18-03739). The use of data in this project was authorized under section 45 of Ontario's Personal Health Information Protection Act, which does not require review by a Research Ethics Board.

Conflicts of interest

The authors have no conflicts of interest to declare.

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