Exploring Changes to the Actionability of COVID-19 Dashboards Over the Course of 2020: Descriptive Assessment and Expert Appraisal in the Canadian Context

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Abstract

Background: Public, web-based COVID-19 dashboards are in use worldwide to communicate pandemic-related information. A global assessment during the early stages of the pandemic on the actionability of COVID-19 dashboards—as a predictor of their potential use for decision-making—revealed features conducive to their actionability were predominately absent. Given the unprecedented speed with which the dashboards were launched and their inherently dynamic nature, the evolution of COVID-19 dashboards with time merits exploration.

Objective: To explore changes to COVID-19 dashboards in the Canadian context over the course of 2020, assessing how the dashboards developed and if the presence of actionability features changed over time.

Methods: We conducted a descriptive assessment and expert appraisal with a panel of scorers (n=8) on a pan-Canadian sample of COVID-19 dashboards (n=26). Scorers assessed the dashboards at two points, in July and November 2020, using an assessment tool informed by communication theory and health care performance intelligence. Using Nominal Group Technique, scorers organized in panels of three, appraised the presence of the seven features of highly actionable dashboards at both time points.

Results: Improvements were made to the dashboards over time, predominately related to data (specificity of geographic break downs, range of reported indicators, explanations of data sources/calculations) and advancements enabled by the technology used (customization of time trends, interactive/visual chart elements). Similarly, improvements to the presence of actionability features were most pronounced for providing data locally, reporting of time trends, and indicator management. No improvements on communicative elements (clarity of purpose and audience) were found. The use of story-telling techniques to narrate trends also remained largely absent from the dashboards.

Conclusions: Improvements to COVID-19 dashboards in the Canadian context over the course of 2020 were mostly driven by advancements that appear related to data availability and dashboard technology. Further increasing the actionability of dashboards for use during public health crises calls for increased attention to both technical and organisational aspects of development processes, including better skill-mixing across disciplines, continued investment in data standards and clearer mandates of their developers for accountability and purpose-driven dashboards.

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Exploring Changes to the Actionability of COVID-19 Dashboards Over the Course of 2020: Descriptive Assessment and Expert Appraisal in the Canadian Context

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Multimedia Appendix
Multimedia Appendix 1: Scoring tool on actionability features
Multimedia Appendix 2: Overview of Canadian COVID-19 dashboards assessed
Multimedia Appendix 3: Scoring distribution and extent of agreement prior to joint workshops

Abstract

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Improvements to COVID-19 dashboards in the Canadian context over the course of 2020 were mostly driven by advancements that appear related to data availability and dashboard technology. Further increasing the actionability of dashboards for use during public health crises calls for increased attention to both technical and organisational aspects of development processes, including better skill-mixing across disciplines, continued investment in data standards and clearer mandates of their developers for accountability and purpose-driven dashboards.

Introduction

Publicly reporting data during a pandemic is a core government function to protect population health and safety [1-3]. It is also critical to foster accountability, transparency, and to support individuals to make informed decisions [4-6]. Unlike past pandemics, COVID-19 has been monitored in real-time globally, with unprecedented collection, analysis and dissemination of data.

Public, web-based COVID-19 dashboards—as dynamic means to visually display information at-a-glance [7]—have surged as a popular approach for sharing pandemic-related information. Dashboards are powerful vehicles for communication; the John Hopkins University coronavirus dashboard [8] reported more than one billion interactions per day by April 2020 [9]. However, without careful selection of indicators and data collection, analysis and visualization, dashboards have the potential to mislead, misinform, and incite panic [10, 11], or simply to be ignored [12].

In the first half of 2020, our international research network of European and Canadian health care performance intelligence professionals [13], launched a global study of COVID-19 dashboards. The study assessed 158 dashboards from 53 countries in July 2020. It also explored what makes dashboards actionable, where actionability refers to a dashboards' potential to inform decision-making by the intended users [14]. More specifically, to be actionable, the information should be both *fit for purpose*—meeting a specific information need—and *fit for use*—placing the right information into the right hands at the right time and in a manner that can be understood [14]. Only 12.7% of dashboards (20/158) appraised in the study were found highly actionable and seven common features were identified between them [15].

Recognizing the speed with which the dashboards were first launched, traditional technical and organizational aspects of development cycles were shortcut [16]. While the urgency of reporting took precedent in the early stages, dashboards by design are flexible and meant to be continuously iterated. Studies also emphasize the importance of frequent reviews to ensure a dashboard's sustained relevance and use [16, 17]. As our initial study was merely a snapshot of the early stages of the pandemic, the extent to which COVID-19 dashboards changed over time was beyond its scope.

Canada presents a relevant context for further investigating the evolution of COVID-19 dashboards for several reasons. First, public health is the remit of federal, provincial/territorial (PT), and local health authorities [18], that, together with PT ministries are involved in monitoring and pandemic reporting. This is reflected in Canada's 2018 multi-actor pandemic (influenza) preparedness plans [19]. In addition to these varied public actors, independent initiatives and the media have leveraged open data sources to also generate public-facing COVID-19 dashboards. The range in types of organizations, and their different target geographies of reporting, have resulted in a diverse dashboard landscape.

Second, Canada's experience with COVID-19 intensified over the course of 2020, with an initial peak in early May (approximately 2,500 daily cases) and second peak in November (approximately 8,000 daily cases) [20]. Cases also spread to areas of Canada previously untouched by the virus [21]. As a result, the demand for dashboards that effectively communicate, and support data-driven decision-making, increased over the course of the year.

Third, Canadian dashboards were criticized early on for possible information blind spots, including failing to report race-based data and other social determinants [22, 23], and for presenting highly aggregated data at PT-level [10, 24, 25]. The extent to which these limitations persisted into the second half of 2020 has yet to be assessed.

In this study, we set out to explore in the Canadian context: how have public, web-based COVID-19 dashboards changed in 2020? And, is there an increase in the actionability of dashboards over time?

Methods

Study design

Our study adheres to the Standards for Reporting Qualitative Research [26]. We applied qualitative methods comprising: (1) a descriptive assessment applying an existing tool [15] for the purposes of systematically and comparatively depicting COVID-19 dashboards; and (2) an expert appraisal using Nominal Group Technique [27, 28] to score the actionability of the dashboards. This study draws on the global sample of 158 dashboards examined in Ivanković et al. (2021) [15], focusing on dashboards reporting on COVID-19 in the Canadian context (n=26). Importantly, we extended data collection for this sample by collecting data for a second time point in order to analyze changes between July 2020 (initial assessment) and November 2020 (second assessment). Additionally, we appraised the presence of actionability features identified in Ivanković et al. (2021) [15] across the sample, at both time points.

Panel of scorers

Data collection was conducted by a panel of eight scorers (EB, DI, SW, KJG, MP, CW, NL, VB). The panel (4 women, 4 men) aligned with the scorers assembled by Ivanković et al. (2021) [15] in order to ensure consistency between assessments. The scorers drew from an existing international research network of Canadian, European, Latin American and Asian researchers, each completing their doctoral research on health care performance intelligence [13]. All scorers had common expertise and training in health care performance data and the use of these data for management and governance, as well as prior training and experience with the study's assessment tool. The panel's composition also included French-language competencies (CW) and prior professional policy and research experience in the Canadian context (EB, DI, SW, KJG, MP, VB).

Assessment instruments

An assessment tool developed, piloted and validated by Ivanković et al. (2021) [15] was applied. The tool assesses COVID-19 dashboards by their purpose and users ("why"), content and data ("what"), and analyses and displays ("how"). Table 1 summarizes the considerations assessed. These considerations derive from communication sciences (i.e. Lasswell model (1948) [29]), the discipline of health care performance intelligence (ie, [14]), earlier studies on public reporting of health performance data and the use of dashboards in the health domain (ie, [30-34]), and guidance for reporting during public health crises of the World Health Organization (WHO) [1]. The tool also aligns with existing Internet-based health information instruments [35, 36].

We operationalized the appraisal of a dashboard's actionability by drawing on the *seven features of highly actionable COVID-19 dashboards* [15] (Table 1). A scoring tool was developed (Multimedia Appendix 1) to appraise each feature on a three-point ordinal scale, scoring each as: present; somewhat present; or not present.

Table 1. Overview of considerations by method applied.

Method	Instrument	Considerations assessed/scored	Guiding questions/statements
Descriptive assessment	Assessment tool[a]	Purpose and audience	Is the purpose and audience mentioned?
		Indicator themes	What indicators are reported on?
		Data	Are data sources and metadata specified?
		Types of analysis	Does the analysis include time trends, geographic and population break downs?
		Presentation	How is data visualized, interpreted, simplified and interacted with?
Expert appraisal	Seven features of highly actionable dashboards scoring tool[b]	Know the audience and their information needs	The intended audience and their information needs are known and responded to.
		Manage the type, volume, and flow of information	The type, volume and flow of information on the dashboard is well managed.
		Report data sources and methods clearly	The data sources and methods for calculating values are made clear.
		Link time trends to policy decisions	Information is reported over time and contextualized with policy decisions made.
		Provide data “close to home”	Data is reported at relevant geographic break downs.
		Break down the population to relevant subgroups	Data is reported by relevant population subgroups.
		Use storytelling and visual cues	Brief narratives and visual cues are used to explain the meaning of data.

[a]Refer to Ivanković et al. (2021) [15] for the full assessment tool.
[b]Refer to Multimedia Appendix 1 for the full scoring tool.

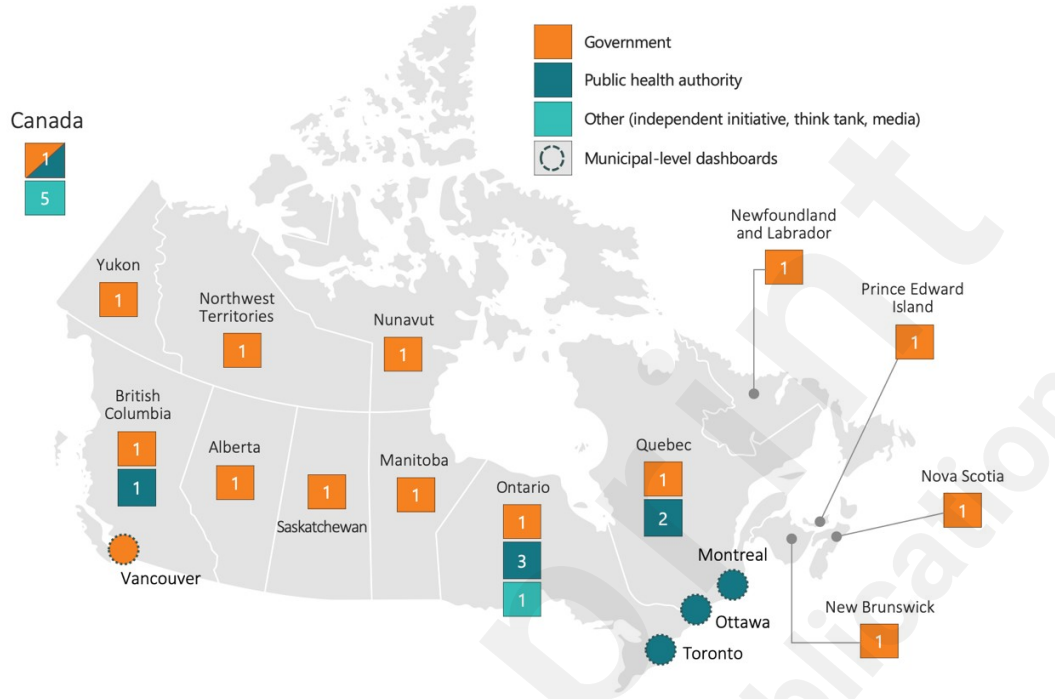
Study sample

COVID-19 dashboards for inclusion were defined based on three criteria: (1) reporting of key performance indicators related to COVID-19; (2) use of some form of visualization; and (3) availability in an online, web-based format. No restrictions were placed on a dashboard’s primary level (eg, national, regional, or local) or the type of organization responsible for its development (eg, government, academia, news or media, industry, or private initiative). Sampling was conducted May 19 to June 30, 2020 and included searches of COVID-19 policy monitoring platforms (eg, North American COVID-19 Policy Response Monitor [37]), reports (eg, a June 2020 pan-Canadian catalogue of governmental COVID-19 dashboards [38]) and expert advice of researchers actively involved in the COVID-19 response reached by email. In total, 31 dashboards reporting on the Canadian context were identified. Of these, five were duplicates and excluded for further analysis. Further details about the sampling are reported in Ivanković et al. (2021) [15].

The final sample (n=26) included dashboards reporting at the national-level (n=6), PT-level (n=16)—with at least one dashboard from each of Canada’s 13 PTs—and municipal-level (n=4), capturing reporting from the capital (Ottawa) and three largest cities (Montreal, Toronto, Vancouver). Figure 1 maps the pan-Canadian distribution and variation in types of organizations responsible for developing the dashboards. These included: federal or PT governments (14/26, 54%); public health authorities (6/26, 23%); and others (6/26, 23%), including independent initiatives (eg, #HowsMyFlattening,

COVID-19 Canada Open Data Working Group), industry (eg, Esri, Deloitte) and media (Canadian Broadcasting Corporation). See Multimedia Appendix 2 for the list of dashboards in full.

Figure 1. Distribution of COVID-19 dashboards sampled and type of organization responsible for their development.



Notes: Circles denote municipal-level dashboards included in the sample and the colour denotes their respective organization types. These dashboards are counted in the tally shown per jurisdiction. The Public Health Agency of Canada's COVID-19 dashboard is hosted on the federal Government of Canada webpage. In other instances, dashboards developed by public health authorities are hosted on dedicated webpages.

Descriptive assessment

The dashboards were assessed by the scorers in English or French. The assessments were limited to a dashboard's main page and content accessible within one interaction (click). This approach aimed to increase the consistency in the content appraised while also gauging the dashboard's prioritization and hierarchy of content. Archives were generated to create a record of the dashboard on the date reviewed (Multimedia Appendix 2). Dashboards were distributed among the scorers as described in Ivanković et al. (2021) [15]. This distribution (average 3 dashboards per scorer) remained consistent between time points: the same scorers assessed the same dashboards both in July and November 2020. All assessments additionally underwent reviews by the first authors to verify their completion and consistency.

Expert appraisal

To score the presence of the seven features of highly actionable COVID-19 dashboards, a series of three-person panels involving the original scorer of each dashboard, joined by two others (the first authors and/or another panel member), were organized in December 2020. Prior to starting the panel series, a workshop of the scorers was organized to calibrate the approach to scoring.

Scoring was informed by the original data records and archives generated during the two descriptive assessments (July and November 2020). In the approach of Nominal Group Technique [27, 28], the three panel members first independently scored the presence of each feature on the dashboard using the scoring tool described above. The proportion of identical ratings for each dashboard were calculated in advance of virtual panel discussions between the three relevant scorers [39, 40].

Prior to the panel discussions, the scorers had reached partial or full agreement (2 or 3-way consensus) on 83.5% of the items scored. Full agreement (3-way consensus) was reached on 50% of items (Multimedia Appendix 3). During the panel discussions, all items where 3-way consensus was not yet reached were debated. Through discussion, re-review of the data records and/or revisiting the archives, each panel reached final agreement.

Data analysis

We used descriptive statistics to analyze the data at the two time points. This included tallying the number and percent of dashboards where each item (consideration) of the descriptive assessment was found present in the July and November assessment. The net change for each item was calculated as the change in total number of dashboards and direction of overall change between time points. To analyze the change in scoring of actionability features, totals were calculated by feature in both July and November according to the three-point ordinal scale applied (not present, somewhat present, present). In the same approach used to analyze changes over time in the descriptive assessment, the net change per feature was calculated as the change in total number of dashboards and direction of overall change.

For free text fields in the descriptive assessment tool, we used both deductive and inductive thematic analysis to identify themes [41, 42]. This applied to considerations including responses to a dashboard's purpose of use and audience, indicator titles and considerations with "other" as an answer category. Topics explored in the assessment tool were used to guide the deductive thematic analysis. We also applied an existing WHO classification of types of pandemic-related information to the analysis of indicator titles reported by the dashboards. This classification was used to analyze the indicators by types of information: public health and epidemiological; health system management; social and economic impact; and behavioral insights [1]. Due to the observed variability in phrasing of indicator titles, key performance indicators were grouped by themes by the first authors. New themes that emerged were identified using an inductive approach.

Ethics approval

This study involved the analysis of publicly available COVID-19 dashboards. Ethics approval was not required.

Results

The 26 Canadian COVID-19 dashboards were assessed in the period July 7 to 20 and again November 23 to December 2, 2020 for an average 135 days between assessments (min=132, max=140). All dashboards remained active with regular, typically daily updating, aside from one (City of Vancouver), which was accessible but last updated in August 2020. As expected, with large differences in population sizes and densities across Canadian PTs, the cumulative number of COVID-19 cases reported by the dashboards for their respective geographic areas ranged from zero cases in Nunavut to more than 55,000 in Quebec in July, and from 15 cases in Northwest Territories to more than 140,000 in Quebec in November. Cumulative numbers of COVID-19 cases and deaths on the dates assessed are reported in Multimedia Appendix 2.

Changes to dashboards over time

Table 2 reports how the dashboards changed over time according to the descriptive assessment. These changes are summarized as follows.

Purpose and audience

There was no change on the extent to which dashboards stated their intended purpose of reporting, with just over a third doing so (10/26, 38%; in both July and November). Where stated, the specific aims of dashboards were most often to provide simplified information in an "easy-to-digest, actionable way" [43] and "[to] help prevention strategies reach those people most affected" [44]. The explicit mention of a target audience was even less frequent. It was found present on just four dashboards in November (4/26, 15%), a marginal increase from July (3/26, 12%). Target audiences were stated as the "general public", "businesses" as well as "public health leaders". Notable improvements were made by Ontario's #HowsMyFlattening [43] over time, with the introduction of two dashboard viewing modes—"personal" and "geek" mode—to serve information needs of different audiences.

Indicator themes

Across the dashboards, public health and epidemiological indicators, followed by health system management indicators, were most frequently reported at both time points, while behavioral and socioeconomic indicators were rare. An average of 7 indicator themes were reported per dashboard in November (min=2, max=17), compared to 6 in July (min=2, max=15). A few indicators became more prevalent in November: viral reproduction rates; testing rates; testing turnaround times; and use of composite scores. Six dashboards (6/26, 23%) reduced the number of indicator themes reported, most often by removing indicators on active cases. In some instances, indicators had been moved from the dashboard to new tabs pages, such as in Ottawa [45] which relocated indicators on behavioral insights to new tabs no longer within the boundaries of the dashboard main page assessed. Indicators on serology tests, doubling rate and testing stock were present on dashboards internationally [15] but were not reported at either time points on the dashboards sampled.

Data sources and metadata

A third of dashboards (8/26, 31%)—all government-developed—did not explicitly report data sources in July or November. The dashboards typically drew data from jurisdiction-specific health services and public health authorities, hospital databases, and, when comparing with other countries, the John Hopkins University coronavirus dashboard. Dashboards reporting metadata (supplementary details on the calculation of the indicators) increased to more than half (14/26, 54%) in November. Notably, the *COVID-19 in Canada* dashboard published a detailed technical report on its dataset through the *COVID-19 Canada Open Data Working Group* initiative [46, 47].

Types of analysis

A slight increase in the number of dashboards reporting time trend data was observed between July

and November (21/26, 81% and 23/26, 88%, respectively). Improvements were made to availability of customizable timescale, allowing users to zoom in on specific timeframes of interest (from 4/26, 15% in July to 10/26, 38% in November).

Changes were made to present sub-regional geographic break downs of data, with more than half (15/26, 58%) of the dashboards including break downs by health regions in November, as compared to 10 (10/26, 38%) in July. Age and sex remained the most common population break downs in November (17/26, 65% and 15/26, 58%, respectively), followed by mode of transmission (6/26, 23%) and long-term care facilities (5/26, 19%). Schools emerged as a new type of break down in November, though present on only a fifth of dashboards (5/26, 19%).

Presentation

Between July and November, most dashboards slightly improved the number and variety of chart types, simplification techniques and interactive features used. This was mostly done by introducing maps and/or additional tables and icons, and user-directed changes to the information displayed. New features that emerged in November included options to subscribe to email updates for alerts (eg, #HowsMyFlattening [43], Ottawa [45]). Two dashboards (Quebec [48], Ontario [49]) introduced user feedback surveys.

Text providing details on data quality was present on more than two-thirds of dashboards in November (18/26, 69%), compared to half in July (13/26, 50%). For example, Esri's dashboard included lay language explanations of values with statements such as: "'Why do I sometimes see negative numbers?' Some values reported (like total cases) are cumulative. They always go up. Other values (like hospitalizations) fluctuate and can go up or down day-to-day" [50].

Narratives to explain the meaning of trends, however, was provided by less than half of the dashboards in November (11/26, 42%). Explanations of trends and their meaning included, for example, this description provided by the *COVID-19 in Canada* dashboard: "Graphs display trends for daily cases and deaths over time on a logarithmic scale. An upward slope means the number of cases/deaths reported each day is still growing. A flat line means the number of cases/deaths reported each day is staying the same. A downward slope means the number of cases/deaths reported each day is falling" [20].

Table 2. Description of changes to Canadian COVID-19 dashboards (n=26) over time in 2020.

Consideration	Described	July value, n (%)	November value, n (%)	Net change[a]
Purpose and audience				
Purpose	Purpose of use of the dashboard stated	10 (38.5)	10 (38.5)	0
Audience	Intended audience (user) stated	3 (11.5)	4 (15.4)	+1
Indicator themes				
Spread and death	Cases (all confirmed cases)	25 (96.2)	25 (96.2)	0
	Deaths	20 (76.9)	21 (80.8)	+1
	Recovered (healed, cured)	17 (65.4)	18 (69.2)	+1
	Active cases	12 (46.2)	12 (46.2)	0
	Mortality rate (case fatality rate)	4 (15.4)	4 (15.4)	0
	Reproduction rates (attack rate)	1 (3.8)	5 (19.2)	+4
Testing	Testing (total number tested, PCR[b] tests)	17 (65.4)	19 (73.1)	+2
	Testing rates (positivity, negative tests)	10 (38.5)	15 (57.7)	+ 5
	Tests pending results	4 (15.4)	2 (7.7)	-2
	Testing turnaround	0 (0.0)	3 (11.5)	+3
Risk management	Self-quarantine (isolation notices)	1 (3.8)	1 (3.8)	0
	Contact tracing	2 (7.7)	2 (7.7)	0
Hospital care	Hospitalized (admissions, discharges)	16 (61.5)	15 (57.7)	-1
	Admitted to ICU[c] (critical condition)	10 (38.5)	12 (46.2)	+2
	On a ventilator	3 (11.5)	3 (11.5)	0
Health system capacity	Hospital bed capacity (availability)	2 (7.7)	2 (7.7)	0
	ICU bed capacity	3 (11.5)	2 (7.7)	-1
	Ventilator capacity (available ventilators)	3 (11.5)	2 (7.7)	-1
	Non-COVID-19 service usage	1 (3.8)	1 (3.8)	0
	Personal protective equipment stock	1 (3.8)	1 (3.8)	0
Economic/ social impact	Employment and hardship relief	4 (15.4)	4 (15.4)	0
	Transport, trade and international travel	2 (7.7)	3 (11.5)	+1
Behavioral	Public risk perception/restriction adherence	5 (19.2)	3 (11.5)	-2
Other	Future projections (modelling)	1 (3.8)	1 (3.8)	0
	Risk-level/current phase (composite score)	2 (7.7)	4 (15.4)	+2
Data sources and metadata				
Sources	Data sources are noted	18 (69.2)	18 (69.2)	0
Metadata	Metadata is specified	11 (42.3)	14 (53.8)	+3
Types of analysis				
Time trend	Time trend analysis available	21 (80.8)	23 (88.5)	+2
	Customizable time trend	4 (15.4)	10 (38.5)	+6
Number of geographic levels	1 level	6 (23.1)	3 (11.5)	-3
	2 levels	14 (53.8)	15 (57.7)	+1
	3 and more levels	6 (23.1)	8 (30.8)	+2
Types of geographic levels of analysis	International	3 (11.5)	3 (11.5)	0
	National	9 (34.6)	8 (30.8)	-1
	Regional (province/territory)	22 (84.6)	22 (84.6)	0
	Health regions	10 (38.5)	15 (57.7)	+5
	Municipal (city)	8 (30.8)	8 (30.8)	0
	Neighbourhood (post-code)	3 (11.5)	2 (7.7)	-1

Disaggregation options	Age	18 (69.2)	17 (65.4)	-1
	Sex	14 (53.8)	15 (57.7)	+1
	Mode of transmission	5 (19.2)	6 (23.1)	+1
	Long-term care facilities	5 (19.2)	5 (19.2)	0
	Schools	2 (7.7)	5 (19.2)	+3
	Ethnicity	0 (0.0)	2 (7.7)	+2
	Race	0 (0.0)	2 (7.7)	+2
	Comorbidities	1 (3.8)	1 (3.8)	0
	Socioeconomic status	1 (3.8)	1 (3.8)	0
	Health workers	3 (11.5)	1 (3.8)	-2
Presentation				
Type of visualization	Table	20 (76.9)	25 (96.2)	+5
	Graph/chart	21 (80.8)	22 (84.6)	+1
	Map	15 (57.7)	18 (69.2)	+3
Narratives to interpret data	Yes, to clarify the quality of the data	13 (50.0)	18 (69.2)	+5
	Yes, to clarify the meaning of the data	12 (46.2)	11 (42.3)	-1
Simplification techniques	Use of colour coding	15 (57.7)	15 (57.7)	0
	Size variation	3 (11.5)	4 (15.4)	+4
	Icons	3 (11.5)	7 (26.9)	-2
Interactive options	More information	18 (69.2)	18 (69.2)	0
	Change of information	7 (26.9)	10 (38.5)	+3
	Change of display	5 (19.2)	6 (23.1)	+1

[a]Net change refers to the total number of dashboards and direction of overall change between time points. Importantly, no net change (0) can mean both no change or the same number of dashboards increased and decreased for the specific consideration.
[b]PCR: polymerase chain reaction.
[c]ICU: intensive care unit.

Actionability features over time

Of the 26 dashboards assessed, no dashboards were found to fully present all seven actionability features in July or November. In total, 8% of dashboards (2/26) were assed to have five or more actionability features fully present in July, compared to 15% of dashboards (4/26) in November. Three quarters of dashboards (77%, 20/26) had two or less features fully present in July, compared with 65% (17/26) in November. Seven dashboards increased their score of fully present features, while two dashboards decreased. This decrease was in large part related to changes in types of information reported on the main dashboard page, as indicators were moved to other dedicated pages.

The most *present* feature in both July and November was the clarity of data sources and methods, while the use of story-telling and visual cues was mostly *not present* (Figure 2). Of the seven actionability features, improvements were found on all but one (know the audience and their information needs), which was *present* on less than a quarter of the dashboards at both time points. Changes were most pronounced for the feature related to geographic break downs, with nearly a quarter increase in the average score between July and November. Second to this were improvements on the use of time trends, though explicit links between data and policy decisions remained infrequent.

Figure 2. Change in actionability across dashboards (n=26) over time in 2020.

	July score Number of dashboards			November score Number of dashboards			Change in score July and November Number of dashboards			
Actionability features	**Not present**	**Somewhat present**	**Present**	**Not present**	**Somewhat present**	**Present**	**Not Present**	**Somewhat present**	**Present**	**Predominate score in November**
1. Know the audience and their information needs	10	10	6	10	10	6	0	0	0	Somewhat present
2. Manage the type, volume, and flow of information	5	17	4	4	16	6	-1	-1	+2	Somewhat present
3. Make data sources and methods clear	5	10	11	4	10	12	-1	0	+1	Present
4. Link time trends to policy decisions	5	19	2	4	18	4	-1	-1	+2	Somewhat present
5. Provide data "close to home"	8	10	8	4	12	10	-4	+2	+2	Somewhat present
6. Break down the population to relevant subgroups	9	14	3	9	13	4	0	-1	+1	Somewhat present
7. Use storytelling and visual cues	13	10	3	12	10	4	-1	0	+1	Not present

Least frequent — Most frequent

Decrease 2 or more — No change — Increase 2 or more

Notes: Not present=the feature is not found on the dashboard; somewhat present=some elements of the feature are present on the dashboard but room for improvement; present=the specific feature is clearly demonstrated and a good practice example of the feature. See Multimedia Appendix 1 for full scoring details and Multimedia Appendix 3 for the level of agreement between panel members.

Discussion

Principal Findings

In this study, we explored changes over the course of 2020 to public, web-based COVID-19 dashboards in the Canadian context. The dashboards sampled varied in their specific geographic focus, yet all shared in their increasing relevance to support decision-making of their respective audiences as the status of COVID-19 intensified across the country. Overall, from the perspective of health care performance intelligence applied, we identified subtle improvements were made to the dashboards between July and November 2020. Improvements were most pronounced regarding dashboard technological solutions (customizable time trends, new charts and graphs) and data (new indicators, more transparency on metadata, more geographic granularity). In the period between assessments, changes to further develop more communicative elements were less pronounced or even absent. These results were mirrored in the scoring of actionability features.

COVID-19 dashboards worldwide are powered by a somewhat common range of software service providers (eg, ArcGIS, Tableau, Power BI). We interpret some improvements observed across our sample can be credited to new technical features rolled out over the course of 2020 by these service providers. For example, the use of adjustable time trends is a feature introduced on more than a third of the dashboards in November and appears as an additional element of the underlying software. However, while industry may be credited with spearheading the technical development of dashboards, the tendency from a technological perspective to measure actionability through *user-clicks* [51], signals its limitations. For example, sophisticating the technology behind more interactive time trends used on dashboards was not complemented with improvements to incorporate policy restrictions into graphs reporting trends over time to signal their effects. This is despite the known advantages of doing so [15] and use of this technique found on dashboards, for example, in Australia [52] and Slovenia [53]. In our sample, we observed dashboards that excelled in their actionability, successfully leveraged skills of technology, data, public health and communication specialists (eg, [43, 54]). This finding is consistent with previous studies reporting the importance of diverse stakeholder engagement for actionable performance measurement, reporting and use [55-57]. We intend to further explore the perspective of dashboard developers in future research, including team composition.

Improved geographic granularity and transparency of methods may be supported by initiatives like the *COVID-19 Canada Open Data Working Group* [20]. The overall subtlety of changes in available data and its specificity might be a symptom of underlying system barriers, in particular the collection and reporting of disaggregated data [58]. Researchers in the Canadian context have called attention to data management issues due to unharmonized privacy laws, public/private custodianship, and challenges to reuse data for research [59]. The collection of race-based data in Canada is fragmented [60] and a pan-Canadian standard was only proposed in July 2020 [61]. There is a responsibility to act when missing data can mask the inequitable burden of the pandemic [62, 63]. The potential equity-promoting impact of sub-population-based approaches to data analysis and its use has already been signalled in Toronto [64]. Countries that have reported race and ethnicity-based COVID-19 data, like New Zealand [65] and the United States [66], may provide insights into needed data governance standards, privacy protections and data infrastructure.

Our findings also signal responsiveness to the evolving nature of the pandemic, with multiple dashboards adding school cases/outbreaks as a data disaggregation option and testing turnaround time as an indicator. Shortly after our second assessment, many dashboards also began reporting on vaccinations. Less advanced dashboards, from areas not affected by the virus in the spring, made considerable progress in the second half of the year as COVID-19 became more widespread. While these changes confirm dashboards continued developing with time, the clarity of their intended aims and audiences remained underdeveloped, despite the fundamental importance of data driven by a clear

purpose and information need [14][67-70]. This may be a symptom of governance constraints, specifically unclear mandates, evidenced by multiple public actors (eg, PT governments and PT public health authorities) reporting on the same geographies with nearly equivalent content. While COVID-19 dashboards began as a need-based, short-term tool for monitoring and communicating on the pandemic, with time this function has evolved. Dashboards must face the mid-term challenge of dual-track monitoring, reporting on both the pandemic and regular health care [71], and the long-term challenge of integration into standard health system performance measurement. Rethinking the development of dashboards with clear mandates will be essential to ensure that relevant high-quality information is transparently delivered to a well-defined audience.

Strengths and Limitations

To our knowledge, this is the first study to comparatively explore and critically reflect on changes to COVID-19 dashboards over time from a health care performance intelligence perspective. The study was enriched by the expertise of the panel, each with prior experience assessing COVID-19 dashboards internationally and a shared reflexive lens to gauge both the technical and communication aspects of the dashboards. Additionally, given the sustained relevance of COVID-19 dashboards, our findings are of pertinence both for short-term improvements to COVID-19 dashboards and their long-term use in future public health crises.

We acknowledge the following limitations. First, the stage of the pandemic and its severity varied considerably across our sample and as a result, the data available and prioritization of the dashboard's development, may differ. Despite this, the direction of change was common, with an average three-fold increase in COVID-19 cases across locations between time points (Multimedia Appendix 2). Second, the expert-based appraisal of actionability used is not a guarantee of a dashboard's use in practice. The firsthand experience of dashboard users merits further study for practical, real-world insights to complement the concepts explored here. Third, the archiving of dashboards was limited to its main page. Dashboards with multiple tabs could, therefore, not be revisited in full for scoring purposes. To minimize the potential loss of information, all dashboards were assessed and appraised by the same scorer in both July and November. Lastly, our sample was limited to dashboards identified in our search in May 2020 for comparisons over time. New dashboards that followed may be missed. An exhaustive sample was beyond the study's aims, though geographic representation, and reasonable diversity in levels (national, jurisdictional, municipal) and organization type, was achieved.

Conclusion

Actionable dashboards are needed for effective decision-making across audiences. Dashboards are a tool of continuing importance, though their sustained actionability demands reactiveness to the pandemic's stages. Improvements made to COVID-19 dashboards between July and November 2020 in the Canadian context appear driven by certain technological and data improvements. The effective use of communication features remained underdeveloped at both time points. COVID-19 dashboard developers need to better leverage the expertise of public health and communication specialists for data to truly become information that is accessible and relevant to a public audience. Strategic system improvements to prioritize data standards (eg, sub-population–based data) appear needed for more significant gains in actionability to be achieved. As the pandemic continues to evolve, it will become of increasing importance for attention to shift towards the transition of dashboards from their initial status as a temporary monitoring and communication tool to one that is integrated into regular health system performance monitoring. Doing so demands improved governance arrangements that clarify roles and responsibilities. Immediate improvements should continue to be made across the seven actionability features to ensure COVID-19 dashboards are fit for purpose and use.

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Authors' Contributors

EB and DI contributed equally as co-first authors. EB, DI, SA, NK, DK designed the study. Data collection was conducted by EB, DI, SW, KJG, MP, CW, NL, and VB. EB and DI drafted the manuscript. All authors revised the article, gave final approval for the version to be published and agreed to be accountable for all aspects of the work.

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Competing interests

None to declare.

Abbreviations

PT: provincial/territorial
WHO: World Health Organization

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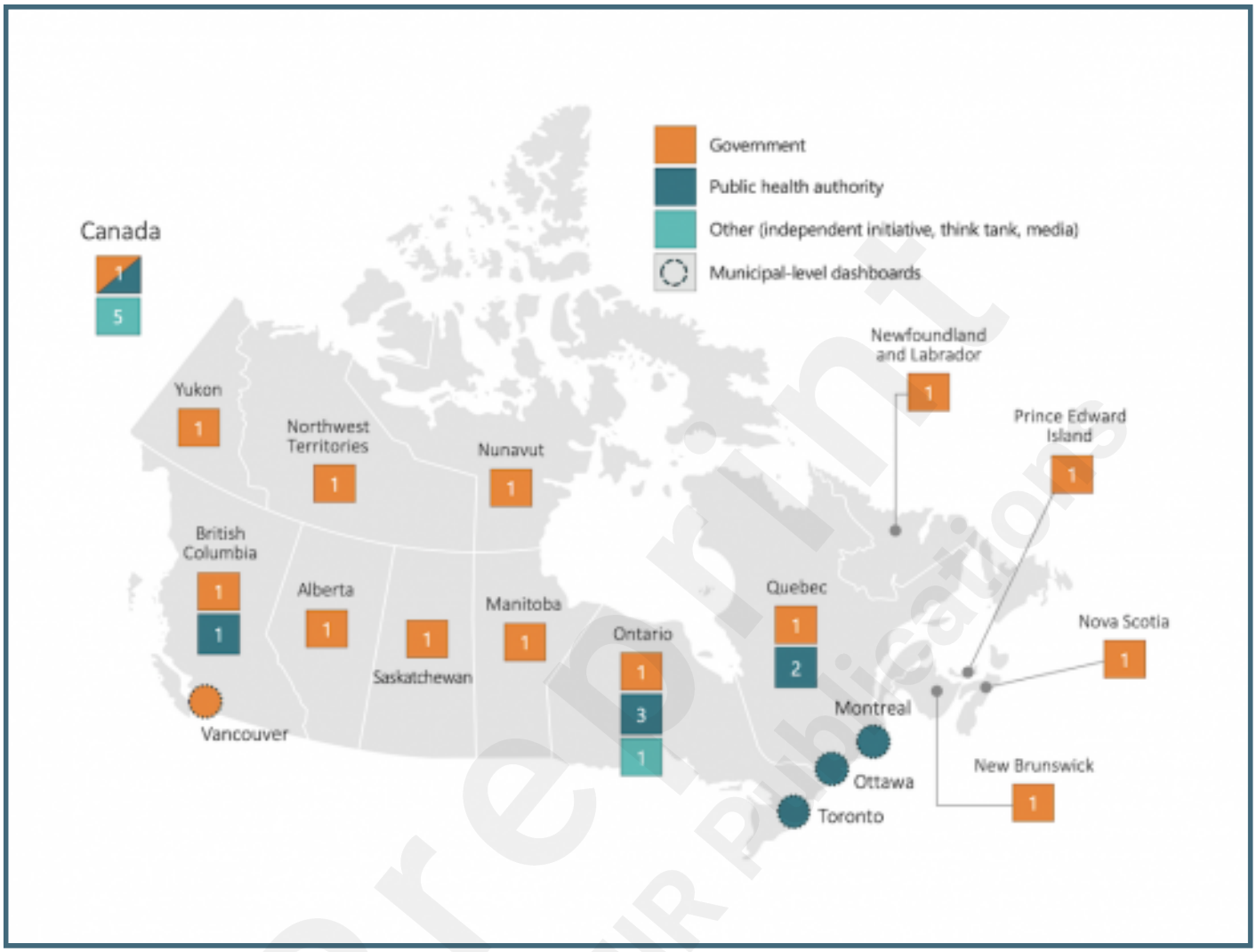
Supplementary Files

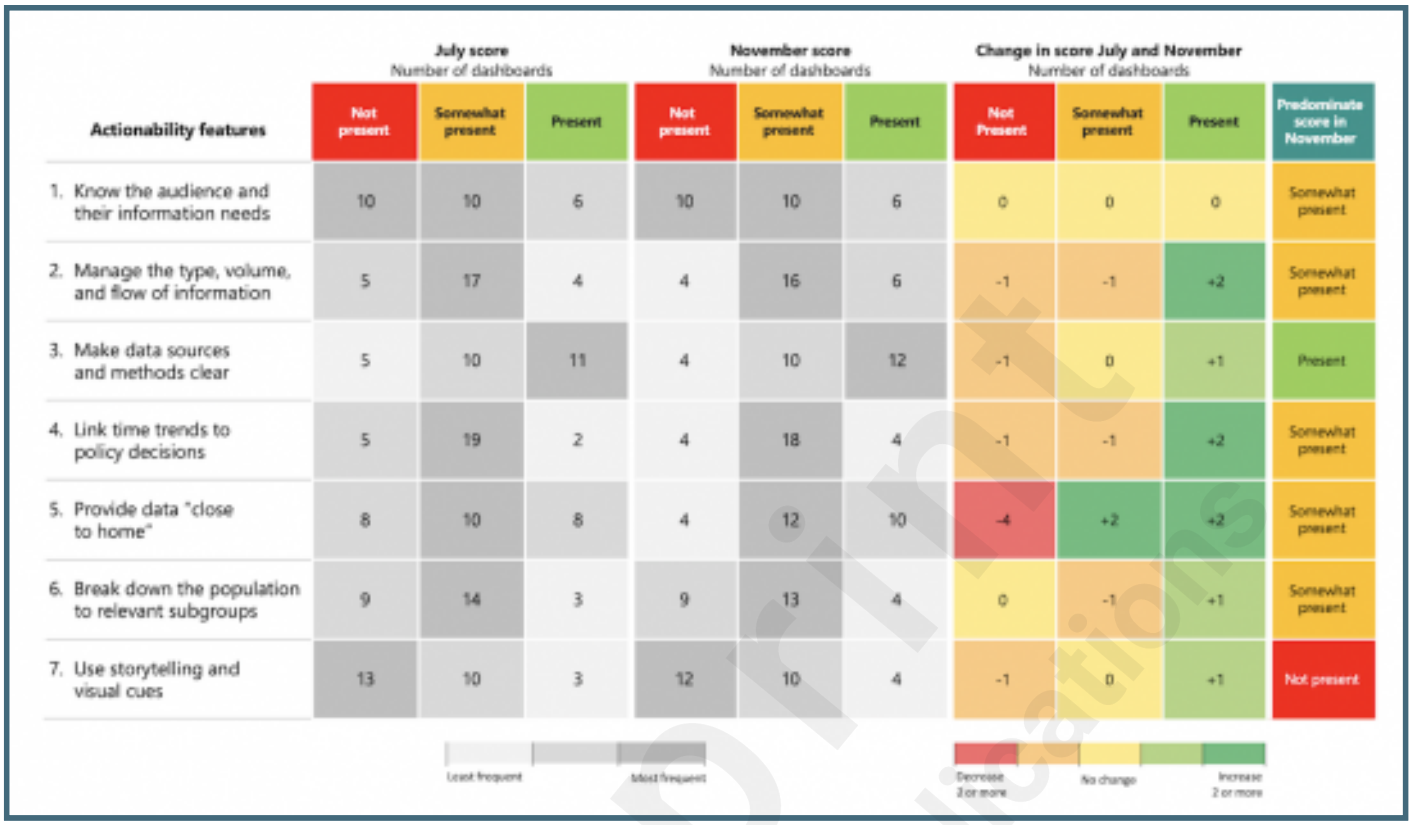
Untitled.
URL: http://asset.jmir.pub/assets/239fb8fd9240229f0371bca902c68e73.pdf

Figures

Distribution of COVID-19 dashboards sampled and type of organization responsible for their development.



Change in actionability across dashboards (n=26) over time in 2020.



Actionability features	July score Number of dashboards: Not present	Somewhat present	Present	November score Number of dashboards: Not present	Somewhat present	Present	Change in score July and November Number of dashboards: Not Present	Somewhat present	Present	Predominate score in November
1. Know the audience and their information needs	10	10	6	10	10	6	0	0	0	Somewhat present
2. Manage the type, volume, and flow of information	5	17	4	4	16	6	-1	-1	+2	Somewhat present
3. Make data sources and methods clear	5	10	11	4	10	12	-1	0	+1	Present
4. Link time trends to policy decisions	5	19	2	4	18	4	-1	-1	+2	Somewhat present
5. Provide data "close to home"	8	10	8	4	12	10	-4	+2	+2	Somewhat present
6. Break down the population to relevant subgroups	9	14	3	9	13	4	0	-1	+1	Somewhat present
7. Use storytelling and visual cues	13	10	3	12	10	4	-1	0	+1	Not present

Multimedia Appendixes

Scoring tool on actionability features.
URL: http://asset.jmir.pub/assets/2ccdbd89c56d16a96e8a5f2cd5e2396b.docx

Overview of Canadian COVID-19 dashboards assessed.
URL: http://asset.jmir.pub/assets/9db499f11e3ea7c703b85239a296792d.docx

Scoring distribution and extent of agreement prior to joint workshops.
URL: http://asset.jmir.pub/assets/bad1b6326d2dd7cc2506ef988746ba25.docx

CONSORT (or other) checklists

Standards for Reporting Qualitative Research (SRQR) checklist .
URL: http://asset.jmir.pub/assets/93f49770a1e2a919aec35da66161a3c5.pdf

TOC/Feature image for homepages

Group of people using dashboard.