A heat map of recommendations for AI applied to life sciences and health technologies in Canada

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Executive Summary (1/4)

◎ Canada is one of the world leaders in artificial intelligence (AI). Life sciences and health technologies (LSHT) has been identified as one of the sectors where Canada can differentiate itself in terms of AI development and implementation.

◎ To identify the next steps in this direction, the Quebec Research Funds (QRF) and Montreal InVivo have made a heat map of recommendations to be considered for the development of the Canadian AI in LSHT sector.

◎ The main recommendations were identified by considering a variety of themes found in the documents produced by several stakeholders across Canada.

◎ **The goal of this initiative is to provide an broad but precise picture of the situation to decision-makers, based on the independent findings of different organizations. This heat map will highlight the gaps to fill, the solutions to consider and the resources required.**

Executive Summary (2/4)

◎ The need to modernize and standardize the federal and provincial regulation for access to health data was identified as a priority for the development and implementation of AI in LSHT. In particular, the timeframe to access data for research and innovation purposes should be shortened in order to improve health care and services. This will also facilitate interoperability between data and information systems while maintaining a high level of security and confidentiality.

◎ Government support will be essential for the development of AI in LSHT, especially in terms of legislative framework, education at the citizen level and the attractiveness of Canada as a destination for top talent in the field.

◎ Funding will be crucial for the development and implementation of AI in the sector, especially when it comes to investing in start-ups and the development of companies, but also to creating jobs and managing task forces, such as Quebec's *Table nationale des directeurs de recherche*.

Executive Summary (3/4)

◎ The development of AI in LSHT would not be possible without the collaboration of the various stakeholders or without the international collaboration. It is important to create and enhance opportunities for stakeholders to discuss and exchange around various topics. These include sharing of expertise, good practices and AI governance systems, collaborative research projects, co-design approaches with patients and professionals, as well as the societal impact of AI.

◎ In order to increase the integration of innovations, to test them in real-world settings and to measure their value, it will be essential to develop the healthcare system's agility by investing in the development of skills and by highlighting the importance of building a culture based on information and measurement.

◎ It is necessary to develop a critical mass of skilled people in AI in health by attracting, educating and retaining them on the territory. Continuing education of people already in the workforce is also essential to promote the implementation of AI in health.

Executive Summary (4/4)

◎ The development of AI in LSHT should be conducted in a transparent and responsible manner, by including citizens at every step of the innovation cycle. The importance of consolidating monitoring activities for the AI in LSHT sector was also frequently mentioned in the consulted documents.

◎ Certain themes were only infrequently touched upon, especially those related to the integration of Indigenous people in the development process and to the consideration of environmental aspects. Another less-frequently mentioned theme was the necessity to digitalize the healthcare network and also to provide a country-wide access to the digital storage and analysis infrastructure necessary for the development of these innovations.

KEY ELEMENTS

1. Objectives and methodology

    - Objectives

    - Methodology

    - References

2. Heat map

    - Heat map by theme

    - Main recommendations by theme

3. Next steps

1.1. Objectives

◎ Create a thematic heat map of published recommendations about AI in LSHT in Canada

◎ Create a map of AI initiatives in LSHT in Quebec

1.2. Methodology

Choice of documents to include in the analysis

- **64** selected documents
  - Suggestions from Carole Jabet (FRQS)
  - Suggestions from Alexandre Le Bouthillier (Imagia)
  - Suggestions from Yves Joanette (Consortium Santé Numérique)
  - White paper and reports from Montreal InVivo
  - Reports from various stakeholders

- **24** chosen documents

1.2. References

Title	Author(s)	Year
Montreal InVivo & partners		
White paper. World Leader of AI in LSHT: A Roadmap	Montreal InVivo & Montréal International	2020
Recommandations sur l'optimisation des processus d'accès aux données de santé en vue du budget provincial 2020-2021 (in French)	Montreal InVivo	2020
Recommandations découlant des consultations sur les modalités d'intégration des innovations technologiques dans le RSSS (in French)	Montreal InVivo	2020
Adequacy diagnosis Training-Skills-Employment	Montreal InVivo, Conseil emploi métropole & Pharmabio	2019
CIFAR & partners		
Building a learning health system for Canadians	CIFAR (AI4H task force)	2020
Application of artificial intelligence approaches to tackle public health challenges	CIFAR & CIHR	2018
AI for public health equity	CIFAR & CIHR	2019
Indigenous protocol and artificial intelligence	Indigenous protocol and AI working group	2020
Universities		
Call to action for a responsible innovation in digital health	Digital Health Consortium	2021
Mémoire – Projet de loi 64 : Accès aux mégadonnées de santé (in French)	Digital Health Consortium	2020
Montreal declaration for a responsible development of artificial intelligence	Université de Montréal	2018
Health data protection law in the era of big data: risks and opportunities for modernization (access with a fee)	Various authors, University of Toronto	2019
Do no harm: a roadmap for responsible machine learning for health care (access with a fee)	Wiens et al., Universities of the United-States and Canada	2019
Government of Canada		
Report of Canada's economic strategy tables: health and biosciences	Canada's economic strategy tables	2018
Integrating robotics, AI and 3D printing technologies into Canada's healthcare system	Standing senate committee on social affairs, science and technology	2017
Task forces and others		
General guidelines to ensure the optimal operation and management of a health data access centre (in French)	Table nationale des directeurs de la recherche, governance and management subgroup	2020
Task force report on artificial intelligence and emerging digital technologies	Royal college of physicians and surgeons of Canada	2020
A jurisdictional scan of global health data resources (restricted use)	Compute-Calcul-Ontario	2019
G-Science academies statement 2020 : Digital health and the learning health system	G-Science Academies 2020	2020
Trustworthy AI in health	Organisation for Economic Co-operation and Development (OECD)	2020
AI on a social mission: Recommendations 2018 – Part 1 AI governance and policy	AI on a social mission	2018
AI on a social mission : Recommendations 2018 – Part 2 The role of education in the implementation of AI (in French)	AI on a social mission	2018
Data Trusts: a new tool for data governance	Element AI & Nesta	2019
Place de l'IA dans les professions: enjeux pour la formation collégiale (in French)	Groupe DDM	2020

1.2. Methodology

Creation of the heat-map

◎ Quick reading of the documents

◎ Validation of criteria* (Canada, Life Sciences, Recommendations)

◎ In-depth reading of the chosen documents

◎ Selection of recommendations

◎ Formatting of the heat map

*with the exception of specific themes

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1.2. Methodology: selected themes

- Data
  - General theme
  - Legislative framework
  - Digital infrastructure/data management
  - Cybersecurity
  - Computer equipment

- Government support

- Funding

- Commercialization/implementation in the healthcare system

- Collaboration between stakeholders

- Continuing and professional education

- Responsible approach
  - Ethics
  - Inclusion and diversity
  - Citizen acceptability

- Environmental impact

1.2. Methodology: definition of the selected themes

Theme		Definition
Data	Global theme	Addresses the topic of data in a general context
	Legal framework	Addresses the necessary changes in the legislative framework around data access and processing
	Digital infrastructure / Data management	Addresses the necessary digital infrastructure and the recommended approaches in data management
	Cybersecurity	Addresses the recommendations about cybersecurity
	Computer equipment	Addresses requirements in terms of computer equipment
Government support		Addresses the government support to be strengthened or implemented
Commercialization / Implementation in the healthcare system		Addresses recommendations regarding commercialization and/or implementation in the healthcare system
Funding		Addresses funding requirements
Collaboration between stakeholders		Addresses how to strengthen or implement collaborations between stakeholders
General and continuing education		Addresses the general and continuing education to be developed
Responsible approach	Ethics	Addresses the ethical aspects to be considered
	Inclusion and diversity	Addresses recommendations related to inclusion and diversity
	Citizen acceptability	Addresses recommendations related to AI citizen acceptability and how to strengthen it
Environmental impact		Addresses the environmental impacts of AI in LSHT

2.1. Number of documents by theme

Theme		Number of documents				Total number of documents mentioning the theme (/24)	
		Most frequently mentioned	Frequently mentioned	Somewhat mentioned	Less frequently mentioned		
Data	Global theme	2	3	3	0	8	22
	Legislative framework	1	5	8	2	17	
	Digital infrastructure/data management	2	5	10	3	20	
	Cybersecurity	0	2	8	6	16	
	Computer equipment	0	1	0	3	4	
Government support		0	7	9	3	19	
Commercialization/Implementation in the healthcare system		1	7	4	6	18	
Funding		0	5	4	4	13	
Collaboration between stakeholders		1	11	9	3	24	
General and continuing education		2	8	5	4	19	
Responsible approach	Ethics	1	7	4	3	15	19
	Diversity and inclusion	2	2	2	5	11	
	Citizen acceptability	0	3	7	2	12	
Environmental impact		0	1	2	3	6	

2.2. Heat map : main recommendations by theme
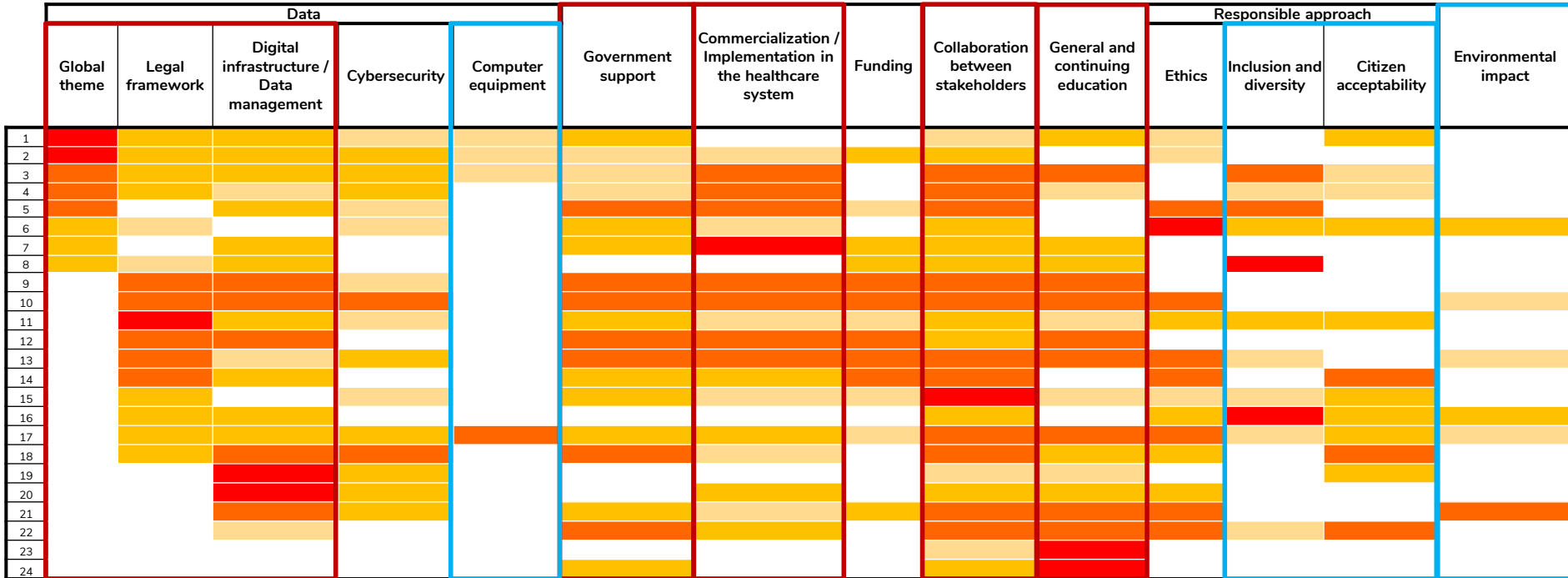
2.2. Sorted bibliography

N°	Title	Author(s)	Year
1	Mémoire – Projet de loi 64 : Accès aux mégadonnées de santé (in French)	Digital Health Consortium	2020
2	Recommandations sur l'optimisation des processus d'accès aux données de santé en vue du budget provincial 2020-2021 (in French)	Montreal InVivo	2020
3	Task force report on artificial intelligence and emerging digital technologies	Royal college of physicians and surgeons of Canada	2020
4	Health data protection law in the era of big data: risks and opportunities for modernization (access with a fee)	Various authors, University of Toronto	2019
5	Do no harm: a roadmap for responsible machine learning for health care (access with a fee)	Wiens et al., Universities of the United-States and Canada	2019
6	Montreal declaration for a responsible development of artificial intelligence	Université de Montréal	2018
7	Recommandations découlant des consultations sur les modalités d'intégration des innovations technologiques dans le RSSS (in French)	Montreal InVivo	2020
8	AI for public health equity	CIFAR & CIHR	2019
9	White paper. World Leader of AI in LSHT: A Roadmap	Montreal InVivo & Montréal International	2020
10	Building a learning health system for Canadians	CIFAR (AI4H task force)	2020
11	Data Trusts: a new tool for data governance	Element AI & Nesta	2019
12	Report of Canada's economic strategy tables: health and biosciences	Canada's economic strategy tables	2018
13	Trustworthy AI in health	Organisation for Economic Co-operation and Development (OECD)	2020
14	AI on a social mission: Recommendations 2018 – Part 1 AI governance and policy	AI on a social mission	2018
15	Integrating robotics, AI and 3D printing technologies into Canada's healthcare system	Standing senate committee on social affairs, science and technology	2017
16	Indigenous protocol and artificial intelligence	Indigenous protocol and AI working group	2020
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23	Place de l'IA dans les professions: enjeux pour la formation collégiale (in French)	Groupe DDM	2020
24	Adequacy diagnosis Training-Skills-Employment	Montreal InVivo, Conseil emploi métropole & Pharmabio	2019

2.2. Main observations

◉ The same themes are found in the recommendations of the various documents

◉ Blind spots:
  - ◉ Few recommendations about the inclusion of indigenous people in the process

  - ◉ Few recommendations about environmental impact of AI in health
    - o Negative impact : reducing the environmental impact of AI in health
    - o Positive impact : using AI to minimize the environmental impact of the healthcare sector

  - ◉ Few recommendations about the importance of upgrading computer equipment and digital network/internet connection across the Canadian territory

Title	Author(s)	Year	Data				
			Gobal theme	Legal framework	Digital infrastructure / Data management	Cybersecurity	Computer equipment
Mémoire - Projet de loi 64 : Accès aux mégadonnées de santé	Digital Health Consortium	2020					
Recommandations sur l'optimisation des processus d'accès aux données de santé en vue du budget provincial 2020-2021	Montreal In Vivo	2020					
Task force report on artificial intelligence and emerging digital technologies	Royal college of physicians and surgeons of Canada	2020					
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AI on a social mission : Recommendations 2018 – Part 2 The role of education in the implementation of AI	AI on a social mission	2018					

Most frequently mentioned theme
Frequently mentioned theme
Somewhat mentioned theme
Less frequently mentioned theme
Never mentioned theme

2.2.1. Main recommendations by theme: data

◎ Very frequently mentioned theme (22/24)

◎ **Global theme (8/24)**
  ◎ Decrease the timeframe for access to healthcare data
  ◎ Importance of recognizing the value of data and using it effectively

◎ **Legislative framework (17/24)**
  ◎ Modernization and standardization of federal and provincial regulation
    ○ Consider data access while protecting the private life and rights of citizens
    ○ Determine liabilities and responsibilities of stakeholders
    ○ Facilitate market entry of innovative products
    ○ Facilitate international collaboration
    ○ Develop an agile regulatory framework for AI-health innovations

  ◎ Develop an audit policy for the use of AI
    ○ Promote the application of best practices by the stakeholders
    ○ Develop international standards

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2.2.1. Main recommendations by theme : data

◎ **Digital infrastructure / Data management (20/24)**
- ◎ Open data principles
- ◎ Importance of interoperability between institutions and databases

◎ **Cybersecurity (16/24)**
- ◎ Importance of securing health data, while allowing them to be shared
- ◎ Protection of data privacy using a « privacy by design » approach

◎ **Computer equipment (4/24)**
- ◎ Upgrade computer equipment in healthcare institutions
- ◎ Provide internet access in data access centers

2.2.2. Heat map by theme: government support

Title	Author(s)	Year	Government support
Do no harm: a roadmap for responsible machine learning for health care	Wiens et al., Universities of the United-States and Canada	2019	
White paper. World Leader of AI in LSHT: A roadmap	Montreal In Vivo & Montréal International	2020	
Building a learning health system for Canadians	CIFAR (AI4H task force)	2020	
Report of Canada's economic strategy tables: health and biosciences	Canada's economic strategy tables	2018	
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AI on a social mission : Recommendations 2018 – Part 2 The role of education in the implementation of AI	AI on a social mission	2018	
Mémoire - Projet de loi 64 : Accès aux mégadonnées de santé	Digital Health Consortium	2020	
Montreal declaration for a responsible development of artificial intelligence	Université de Montréal	2018	
Recommandations découlant des consultations sur les modalités d'intégration des innovations technologiques dans le RSSS	Montreal In Vivo	2020	
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Adequacy diagnosis Training-Skills-Employment	Montreal InVivo, Conseil emploi métropole & Pharmabio	2019	
Recommandations sur l'optimisation des processus d'accès aux données de santé en vue du budget provincial 2020-2021	Montreal In Vivo	2020	
Task force report on artificial intelligence and emerging digital technologies	Royal college of physicians and surgeons of Canada	2020	
Health data protection law in the era of big data: risks and opportunities for modernization	Various authors, University of Toronto	2019	

Most frequently mentioned theme
Frequently mentioned theme
Somewhat mentioned theme
Less frequently mentioned theme
Never mentioned theme

2.2.2. Main recommendations by theme : government support

◎ Frequently mentioned theme (19/24)

◎ **Government support is important at all levels, especially for the legislative framework**

◎ Relevant ministries and government agencies (especially Health Canada) should be involved

◎ Role in educating citizens about digital literacy

◎ Role in promoting the attractiveness of the sector for skilled individuals (immigration policies)

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2.2.3. Heat-map by theme : funding

Title	Author(s)	Year	Funding
White paper. World Leader of AI in LSHT: A roadmap	Montreal In Vivo & Montréal International	2020	
Building a learning health system for Canadians	CIFAR (AI4H task force)	2020	
Report of Canada's economic strategy tables: health and biosciences	Canada's economic strategy tables	2018	
Trustworthy AI in health	OECD	2020	
AI on a social mission: Recommendations 2018 – Part 1 AI governance and policy	AI on a social mission	2018	
Recommandations découlant des consultations sur les modalités d'intégration des innovations technologiques dans le RSSS	Montreal In Vivo	2020	
AI for public health equity	CIFAR & CIHR	2019	
Recommandations sur l'optimisation des processus d'accès aux données de santé en vue du budget provincial 2020-2021	Montreal In Vivo	2020	
Application of artificial intelligence approaches to tackle public health challenges	CIFAR & CIHR	2018	
Do no harm: a roadmap for responsible machine learning for health care	Wiens et al., Universities of the United-States and Canada	2019	
Data Trusts: a new tool for data governance	Element AI & Nesta	2019	
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Call to action for a responsible innovation in digital health	Digital Health Consortium	2021	

Most frequently mentioned theme
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Less frequently mentioned theme
Never mentioned theme

2.2.3. Main recommendations by theme: funding

◎ Occasionally mentioned theme (13/24)

◎ To support the development of AI companies, it will be essential to:
  - Attract investors
  - Scale startups and companies
  - Retain companies and talent in the country

◎ To facilitate AI implementation, it will be essential to:
  - Create jobs in the field
  - Ensure the continuity of task forces, such as the *Table nationale des directeurs de recherche*

2.2.4. Heat map by theme: commercialization and implementation

Title	Author(s)	Year	Commercialization / Implementation in the healthcare system
Recommandations découlant des consultations sur les modalités d'intégration des innovations technologiques dans le RSSS	Montreal In Vivo	2020	
Task force report on artificial intelligence and emerging digital technologies	Royal college of physicians and surgeons of Canada	2020	
Health data protection law in the era of big data: risks and opportunities for modernization	Various authors, University of Toronto	2019	
Do no harm: a roadmap for responsible machine learning for health care	Wiens et al., Universities of the United-States and Canada	2019	
White paper. World Leader of AI in LSHT: A roadmap	Montreal In Vivo & Montréal International	2020	
Building a learning health system for Canadians	CIFAR (AI4H task force)	2020	
Report of Canada's economic strategy tables: health and biosciences	Canada's economic strategy tables	2018	
Trustworthy AI in health	OECD	2020	
AI on a social mission: Recommendations 2018 – Part 1 AI governance and policy	AI on a social mission	2018	
Call to action for a responsible innovation in digital health	Digital Health Consortium	2021	
General guidelines to ensure the optimal operation and management of a health data access centre	Table nationale des directeurs de la recherche, governance and management subgroup	2020	
AI on a social mission : Recommendations 2018 – Part 2 The role of education in the implementation of AI	AI on a social mission	2018	
Recommandations sur l'optimisation des processus d'accès aux données de santé en vue du budget provincial 2020-2021	Montreal In Vivo	2020	
Montreal declaration for a responsible development of artificial intelligence	Université de Montréal	2018	
Data Trusts: a new tool for data governance	Element AI & Nesta	2019	
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Never mentioned theme

2.2.4. Main recommendations by theme: commercialization and implementation in the healthcare system

◎ Frequently mentioned theme (18/24)

◎ It is necessary to effectively measure the value of innovations implemented in the healthcare system

◎ It is necessary to test AI-health innovations in real-world settings

◎ The agility of the healthcare system should be improved in order to facilitate the implementation of innovations

◎ Public and private sectors collaborations should be developed

◎ It is essential to support to the development of AI-health companies

◎ It is important to implement AI-health innovations across Canada

◎ Job market transformation :
  ◎ The impact of AI will have to be measured
  ◎ It will be necessary to add new jobs to support implementation of such innovations in the healthcare system

2.2.5. Heat map by theme: collaboration between stakeholders

Title	Author(s)	Year	Collaboration between stakeholders
Integrating robotics, AI and 3D printing technologies into Canada's healthcare system	Standing senate committee on social affairs, science and technology	2017	
Task force report on artificial intelligence and emerging digital technologies	Royal college of physicians and surgeons of Canada	2020	
Health data protection law in the era of big data: risks and opportunities for modernization	Various authors, University of Toronto	2019	
Do no harm: a roadmap for responsible machine learning for health care	Wiens et al., Universities of the United-States and Canada	2019	
White paper. World Leader of AI in LSHT: A roadmap	Montreal In Vivo & Montréal International	2020	
Building a learning health system for Canadians	CIFAR (AI4H task force)	2020	
Trustworthy AI in health	OECD	2020	
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A jurisdictional scan of global health data resources	Compute-Calcul-Ontario	2019	
Place de l'IA dans les professions: enjeux pour la formation collégiale - étude DDM	Groupe DDM	2020	

Most frequently mentioned theme
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Never mentioned theme

2.2.5. Main recommendations by theme: collaboration between stakeholders

◎ Very frequently mentioned theme (24/24)

◎ Collaboration is essential
  ◎ Between the stakeholders (government, government agencies, researchers, companies, students, citizens, patients, physicians…)
  ◎ Internationally
  ◎ With countries that have less access to data or to the digital infrastructures needed for the development of innovations in AI

◎ Create of events (national conferences, innovations forums, etc.) to foster exchanges between stakeholders

◎ Enhance collaborations by establishing open data principles, data interoperability and the standardization of legal frameworks

◎ Promote multidisciplinary environments (at work, in universities, in academia, etc.)

◎ Develop public-private partnerships

2.2.6. Heat map by theme: general and continuing education

Title	Author(s)	Year	General and continuing education
Place de l'IA dans les professions: enjeux pour la formation collégiale - étude DDM	Groupe DDM	2020	
Adequacy diagnosis Training-Skills-Employment	Montreal InVivo, Conseil emploi métropole & Pharmabio	2019	
Task force report on artificial intelligence and emerging digital technologies	Royal college of physicians and surgeons of Canada	2020	
White paper. World Leader of AI in LSHT: A roadmap	Montreal In Vivo & Montréal International	2020	
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A jurisdictional scan of global health data resources	Compute-Calcul-Ontario	2019	

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Never mentioned theme

2.2.6. Main recommendations by theme: continuing and professional education

◎ Frequently mentioned theme (19/24)

◎ The pool of skilled people should be expanded by attracting, training and retaining them in Canada

◎ **Continuing education :**
- ◎ Existing employees, stakeholders and citizens should receive training around the AI, in particular its definition, implications and ethical aspects

◎ **General education :**
- ◎ There is a need to train more students with a double expertise in AI and biology, and multidisciplinarity should be enhanced
- ◎ There is a need for effective training in mathematics and physics, in AI implication and in ethics
- ◎ Focus on university training for the time being, since the development of AI seems inseparable from academic research
- ◎ Increase internship opportunities
- ◎ Consider providing simplified data access to students

Title	Author(s)	Year	Responsible approach		
			Ethics	Inclusion and diversity	Citizen acceptability
Montreal declaration for a responsible development of artificial intelligence	Université de Montréal	2018	[most frequent]	[somewhat]	[somewhat]
Do no harm: a roadmap for responsible machine learning for health care	Wiens et al., Universities of the United-States and Canada	2019	[frequent]	[frequent]	[never]
Building a learning health system for Canadians	CIFAR (AI4H task force)	2020	[frequent]	[never]	[never]
Trustworthy AI in health	OECD	2020	[frequent]	[less frequent]	[never]
AI on a social mission: Recommendations 2018 – Part 1 AI governance and policy	AI on a social mission	2018	[never]	[never]	[frequent]
Call to action for a responsible innovation in digital health	Digital Health Consortium	2021	[somewhat]	[less frequent]	[somewhat]
Application of artificial intelligence approaches to tackle public health challenges	CIFAR & CIHR	2018	[frequent]	[never]	[never]
AI on a social mission : Recommendations 2018 – Part 2 The role of education in the implementation of AI	AI on a social mission	2018	[frequent]	[less frequent]	[frequent]
Indigenous protocol and artificial intelligence	Indigenous protocol and artificial intelligence working group	2020	[somewhat]	[most frequent]	[somewhat]
Data Trusts: a new tool for data governance	Element AI & Nesta	2019	[somewhat]	[somewhat]	[somewhat]
G-Science academies statement 2020 : Digital health and the learning health system	G-Science Academies 2020	2020	[somewhat]	[never]	[frequent]
General guidelines to ensure the optimal operation and management of a health data access centre	Table nationale des directeurs de la recherche, governance and management subgroup	2020	[somewhat]	[never]	[never]
Mémoire - Projet de loi 64 : Accès aux mégadonnées de santé	Digital Health Consortium	2020	[less frequent]	[never]	[somewhat]
Recommandations sur l'optimisation des processus d'accès aux données de santé en vue du budget provincial 2020-2021	Montreal In Vivo	2020	[less frequent]	[never]	[never]
Integrating robotics, AI and 3D printing technologies into Canada's healthcare system	Standing senate committee on social affairs, science and technology	2017	[less frequent]	[never]	[somewhat]
AI for public health equity	CIFAR & CIHR	2019	[never]	[most frequent]	[never]
Task force report on artificial intelligence and emerging digital technologies	Royal college of physicians and surgeons of Canada	2020	[never]	[frequent]	[less frequent]
Health data protection law in the era of big data: risks and opportunities for modernization	Various authors, University of Toronto	2019	[less frequent]	[less frequent]	[never]
A jurisdictional scan of global health data resources	Compute-Calcul-Ontario	2019	[never]	[never]	[somewhat]

Most frequently mentioned theme
Frequently mentioned theme
Somewhat mentioned theme
Less frequently mentioned theme
Never mentioned theme

2.2.7. Main recommendations by theme : responsible approach (ethics, diversity, inclusion)

◎ Frequently mentioned theme (19/24)

Ethics (15/24)
◎ Develop responsible AI (proposal for an « Ethical AI » certification)

◎ The added value of AI should be determined
  ◎ For the healthcare system
  ◎ For companies : creation of a social impact index

◎ Transparency in AI processes and operations is crucial

◎ Develop research on the social impact of AI

◎ Equity/fairness is an essential dimension to consider
  ◎ In AI processes
  ◎ In the implementation of AI and access to its uses
  ◎ In the distribution of the benefits of AI (economic or otherwise)

◎ Data biases should be taken into account

MONTRÉAL INVIVO

Fonds de recherche
Santé
Québec

2.2.7. Main recommendations by theme: responsible approach (ethics, diversity, inclusion)

Inclusion and diversity (11/24)
- Foster an inclusive development of AI

Citizen acceptability (12/24)
- The integration of citizens in the development of AI is essential

- Citizens should be educated
  - About AI and its implications
  - About digital literacy

- Transparency and communication around the limitations of AI are crucial

2.2.8. Heat map by theme: environmental impact

Title	Author(s)	Year	Environmental impact
Application of artificial intelligence approaches to tackle public health challenges	CIFAR & CIHR	2018	
Montreal declaration for a responsible development of artificial intelligence	Université de Montréal	2018	
Indigenous protocol and artificial intelligence	Indigenous protocol and artificial intelligence working group	2020	
Building a learning health system for Canadians	CIFAR (AI4H task force)	2020	
Trustworthy AI in health	OECD	2020	
Call to action for a responsible innovation in digital health	Digital Health Consortium	2021	

2.2.8. Main recommendations by theme : environmental impact

◎ Infrequently mentioned theme (6/24) → blind spot

◎ Direct and induced environmental footprint should be measured

◎ There is a need for more effective ways to reduce the environmental impact of AI-based technologies

◎ AI-based technologies should be used to reduce the environmental impact of the healthcare sector

2.2.9 Recommendation to sustain/reinforce/disseminate monitoring activities

In particular, those related to:

- o Ethics (implications, responsible use)

- o Implementation of AI

- o Impacts of AI (on the economy, the job market, society and societal welfare)

- o Citizen acceptability (public consultations, complaints management...)

3. Next steps

- ◉ Mapping of AI initiatives in LSHT, in collaboration with Forum IA Québec
  - ○ Mapping of companies and support organizations (Forum IA Québec)
  - ○ Mapping of research groups and initiatives in healthcare institutions (Montréal InVivo)
  - ○ Lists of various categories of AI utilization in LSHT (initial lists presented in the Appendix)

Appendix

Additional details

DHDP Initiative

Digital Health & Discovery Platform
Digital · Hôpital
Découverte · Plateforme

ACCELERATE
Building the Digital Health and Discovery Platform
Bâtir la Digital - Hôpital - Découverte - Plateforme (DHDP)

24 & 25 February 2021

1267* Global Attendees from **11** Countries

Presentations from **14** Key Opinion Leaders

Panel Discussion
6
Canadian Healthcare Influencers

RFP Announcement Launch Q2, 2021

Digital Health & Discovery Platform

C CATALYST
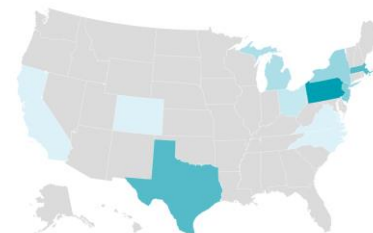Program

Digital · Hôpital
Découverte · Plateforme

Cross-training interdisciplinary

41 EU

Key Sectors Represented

Research University Hospital
Oncology Biotech
Government Funders Neuroscience
Pharmaceutical Industry
SME AI Provincial Health Authority
Venture Capital Genomics

61 USA

582 Pan-Canadian

INVIVO

Welcome Session link

*Over 2 days

Executive Director

Chief Data Officer

Shari Dworkin

"Combining contextual clinical data with the latest in data science technologies will accelerate medical breakthroughs, improve outcomes for patients, and deliver a more efficient & accessible healthcare system."

"Data and digital assets should be used to improve the health care system and deliver the best care for patients"

Guillaume Bourque
Associate Professor Human Genetics, McGill University

Diane Côté
CEO, Medteq

Rodney Ouellette
President and Scientific Director, Atlantic hospital

Nicole Mittmann
CSO & VP Evidence Standards, CADTH

Valérie Pisano
CEO, Mila

Francois Benard
VP Research BC Cancer Care

Andrew Casey
President & CEO BioteCanada

Benjamin Haibe-Kains
Senior Scientist, UHN

Laszlo Radvanyi
CEO, OICR

Nadine Beauger
CEO, IRICOR

Fabrice Brunet
CEO, CHUM

David McFarlane
VP Global Alliances, Kinova

Colette Kaminsky
Assistant Associate Deputy Minister, ISED (DHDP Observer)

Guy Rouleau
Director, The Neuro

Kirk Rockwell
COO AMII

Roxana Sultan
VP Health, Vector

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The AI-Health Sector

List of stakeholders and categories of AI utilization

Sectors of innovation for AI in health

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200+ AI stakeholders in the province of Quebec

By stakeholder type

- 57 companies in AI-health
- 75% of the 180 MEDTEQ+ members
- 13 big pharmas (CQDM), Lab IA Novartis and Roche AI Center of Excellence
- 36 academic centers (Mila, IVADO, IID, McGill, ETS, Poly,UdeS)
- Data lakes/banks (CITADEL, Pulsar, McGill, Jewish General Hospital OROT, PARS3, Cartagene)
- CHUM School of Artificial Intelligence in Health (SAIH)
- Patient portal: Horace, OncoQuébec
- Consortium Santé Numérique
- ISQ, MSSS, INESSS, MEI, FRQS, Prompt
- Genome QC
- Discoveries and collaborations : DHDP.ca

2 septembre 2021

Alexandre Le Bouthillier

List of the 57 Quebec-based AI-health SMEs

Agent Health
AI Genetika
Aifred Health
AlayaCare
AFX Medical
Arkangel AI
Arthur Inteligence
Beam Me Up Labs
Castella Medical
Chronometriq Inc
Cogilex R&D Inc.
Diagnos
Dialogue
Factually Health
Gray Oncology Solutions
GreyBox Solutions Inc.

Haleo Preventive Health Solutions
Hexoskin (Carré Technologies)
Iaso Genetics
Imagia
Imeka
Innodem Neurosciences
Lixr AI
Logibec
Lumed
Medvalgo
Mind Mental Health Technologies
mind.me
Mr Young

My Intelligent Machines
Myelin
Neurotracker
ODS Medical
Oppimi Group
Opportune Therapeutics
Optina Diagnostics
Perceiv AI
Perigen
PetalMD
Phyla
Plakk
Prehos
Quinditech
Saccade Analytics
Scribens Project

Shaddari Therapeutics
Simmunome AI
Skullscan Technologies
Tactio Health Group
Trois Prime Inc.
True Positive Medical Devices
Ubenwa Health
Valence Discovery
Virtual Rehab
VitalTracer
Zilia

Large companies: Telus, CellCarta, ...

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Distribution of the 57 Quebec-based AI-health SMEs

Telemedicine & in-home care
12.3%

Digital Discovery Platform
1.8%

Clinical Trials
1.8%

Diagnosis
7.0%

Mental Health
10.5%

Wearables
3.5%

Emergency Room & Surgery
1.8%

Healthcare Assistance Robots
1.8%

Research
3.5%

Drug Discovery
7.0%

Patient Data & Risk Analysis
12.3%

Inpatient Care & Hospital Management
5.3%

Medical Imaging & Diagnostics
22.8%

Lifestyle Management & Patient Monitoring
8.8%

Source: Imagia, 2021