Appendix: A. Supplementary Tables and Figures

Table A1: Surgery Rates and Proportion Day/Outpatient and Laparoscopic, 2022 or most recent

		Australia	Belgium	Canada	Denmark	France	Italy	Korea	Netherlands	Norway	Spain	Sweden	Switzerland	United Kingdom
Cataract Surgery	Procedures per 100,000 Inhabitants	1,110.5	1,305	1,103.6	1,287.7	1,493	980.2	1,471.6	1,203.2	392.4	1046.9	1,285.8	455.5	956.2
	Proportion Day or Outpatient Surgery (%)	97.96	97.01	99.87	99.51	97.27	98.16	94.77	99.91	96.41	99.34	98.85	90.34	99.51
Appendectomy	Procedures per 100,000 Inhabitants	22.6	39	1.4	6.3	40.8	18	76.9	1.1	14.1	6.9	14.8	44	4.7
	Proportion Day or Outpatient Surgery (%)	1.16	2.22	14.15	9.05	4.95	0.17	0.27	3.17	4.64	1.33	6.79	0.72	3.48
	Proportion Laparoscopic (%)	93.60	92.62	94.93	94.00	91.36	79.97	90.31	93.57	91.85	78.60	84.66	90.70	85.49
Cholecystectomy	Procedures per 100,000 Inhabitants	221.2	227.1	191.1	152.1	181	172.7	181.9	140.7	133.6	179.5	148.9	208.1	101.9
	Proportion Day or Outpatient Surgery (%)	5.38	12.81	56.41	44.97	44.14	2.03	0.16	40.16	42.22	11.53	31.90	4.32	52.11
	Proportion Laparoscopic (%)	95.34	94.58	96.39	95.20	94.20	91.02	92.58	95.52	97.16	90.19	93.22	92.17	92.54
Repair of inguinal hernia	Procedures per 100,000 Inhabitants	158.3	224.4	166.9	173.8	227.7	198	66.3	142.8	111	220.4	160.2	260.9	90
	Proportion Day or Outpatient Surgery (%)	30.13	54.50	80.53	85.85	73.30	53.99	17.19	86.48	72.43	55.76	81.59	39.75	74.56
	Proportion Laparoscopic (%)	48.64	60.07	18.99	66.69	45.63	5.96	46.15	53.57	72.70	13.84	8.30	60.37	20
Hip Replacement	Procedures per 100,000 Inhabitants	185.8	282.9	181.8	282.8	255.8	211.8	68.2	241.2	276.7	137.6	264.5	338.4	175.2
	Proportion Day or Outpatient Surgery (%)		0.14	15.84	4.03	3.71	0	0.15	0	0.51	0	2.38	0.06	1.48
Knee Replacement	Procedures per 100,000 Inhabitants	214.7	180.6	202.5	227.9	185.5	155	159.9	128.3	122.7	134.6	143.9	303.6	116.3
	Proportion Day or Outpatient Surgery (%)		0.11	17.33	9.74	3.45	0	0.06	0	0.90	0	7.30	0.03	1.63
CABG	Procedures per 100,000 Inhabitants	49.5	57.5	48.8	26.7	25.7	29.6	10.1	43.5	22.5	15.4	25	38.5	19.1

Source: OECD Health Statistics. Measure: Surgery Rates. 2022 or most recent.

Table A2: Causes of Mortality, Deaths per 100,000 Inhabitants (2020, or most recent available)					
	Total	**Neoplasms**	**Endocrine, nutritional and metabolic diseases**	**Diseases of the respiratory system**	**Diseases of the circulatory system**
Australia	639.9	194.3	29.2	49.7	161.2
Canada	755.1	201.9	26.7	57.0	179.7
Denmark	815.1	236.7	26.2	84.0	171.5
France	726.5	200.1	24.3	40.3	139.3
Germany	850.0	213.2	31.2	52.4	282.4
Italy	802.6	206.2	35.7	58.7	231.9
Japan	586.6	180.4	9.9	66.7	142.9
Korea	635.8	163.4	20.9	80.7	128.8
Netherlands	821.2	226.9	17.8	50.5	171.2
Norway (2016)	764.7	212.7	18.8	81.8	204.0
Spain	777.7	192.5	23.4	64.4	182.5
Sweden	786.7	190.0	24.3	43.5	222.1
Switzerland	728.0	173.0	14.6	35.6	191.2
United Kingdom	895.9	227.2	15.5	88.6	196.3
United States	1,045.3	188.2	50.4	83.6	282.9
Average	775.4	200.4	24.6	62.5	192.5

Source: OECD Causes of Mortality.

B. Survey Questionnaire and Methods

The qualitative data were gathered from surveying participants in an online workshop, as well as long form interview discussions with individuals throughout the health sector, by invitation. Altogether between the two groups, data were collected from 53 contributors.[1] Interview participants include frontline workers, researchers, hospital executives, regional administrators, foundation board members, medical supply company executives, group purchasing organization executives, and former health ministers and deputy ministers. Both groups were asked about critical barriers and drivers of innovation, lessons learned from their own experiences, and recommendations for changes that would increase capacity to innovate (See Box B1 below for questionnaire). Survey and workshop participants were selected from the C.D. Howe Institute Health Policy Council members and through snowball sampling techniques. Qualitative interview participants have been given anonymity in the reporting of the data, meaning any quotations from an individual participant are not attributed and are paraphrased in some cases.

The qualitative interview data were processed in two ways. First, Claude.ai (using concise responses) was asked to summarize insights from transcripts of the interviews in categories that align with both the interview questionnaire and those used during the online workshop. This concise summary of data allows for aggregation of the two data sources to provide an overview of the drivers and barriers of innovation, key stakeholders and recommendations for improvement (Figures 6, 7, 8). Supplementary analysis of the interview transcripts included theme analysis and comparison of the results across a number of potentially conflicting views (political views, public/private entities, management/frontline) to test for sensitivity of the results to the participant selection process (since snowball sampling is a non-random survey method). The results showed that the drivers and barriers of innovation, and critical stakeholders identified, were similar between the potentially opposing participant groups. These results are not reported in part due to lack of sensitivity of the results, and also due to small sample sizes.

The theme analysis consistently highlighted three general categories of innovative activities: organizational/ process changes, capital investment and equipment, and improving health information and data (particularly data related to patient identification/intervention/management and evidence of effectiveness related to the other two categories). Case studies were selected from the experiences of interview participants with implementing (or trying to implement) innovative technologies, process, or tools, summarized from the full transcripts using Claude.ai[2] and augmented with additional, publicly available information. The case studies each highlight one of the major themes to show examples of different types of innovative activities in hospitals.

1 The online survey had a 66 percent response rate from participants (n=33), while the long form interviews had a response rate of 80 percent (n=20).

2 Claude's 'voice' was developed with examples of C.D. Howe Institute health policy publications and was given a knowledge base of data and resources from provincial government sources, Healthcare Excellence Canada, the OECD and CIHI.

Box B1: Interview Questions and Protocols

Each interview participant was interviewed for at least half an hour. Participants were given an overview of the research questions and goals before being asked to share their experiences. In some cases, interview participants did not have a response to all questions, if they did not have direct experience or expertise to provide (for example, a frontline provider might not have expertise about public procurement policy, or a regional/provincial administrator might not have direct experience in clinical care.) As a result, participants were free to skip questions if so chose. Similarly, each interview contained an open-ended portion at the end for participants to provide any additional thoughts, experiences or recommendations that they felt were relevant.

State of the Healthcare System and Capacity

1. How would you describe the current state of hospital capacity in [relevant jurisdiction]?
2. In your opinion, how well do Canadian hospitals evolve and innovate? What do we do well and what do we do poorly?
3. What are the barriers or impediments to process innovation?
4. What are the barriers or impediments to technology adoption and innovation? (large capital equipment, efficiency enhancing software, etc.)
5. If you could do 3 things to make Canadian hospitals more innovative and increase their capacity to provide care, what would you do?
6. If the government could do one thing to improve innovative capacity for hospitals, what should they do?
7. Do you have a success story to share? A time in your career when significant process innovation was achieved or an innovation project was implemented and scaled with positive outcomes for patients. What factors needed to come together to achieve that success?
    a. If success is pilot, ask follow-up: why didn't it continue to full adoption or why didn't it scale?
8. Alternatively, can you tell me about a time you tried implementing an innovative idea and were frustrated or unsuccessful?
    a. What would need to happen or change for you to try again or for it to have been successful?
9. Who are the key decision-makers? How does information flow to them and do you think they have all the information to make good decisions? If not, what are they missing?

Systemic Factors:

- Are there funding or systemic structural factors that limit hospitals' ability to adopt new innovations? Please explain/describe.
- Do you think that different funding mechanisms such as bundled payments, risk-sharing between public and private sector, or some other funding mechanism would significantly improve innovation capacity?
- What's the minimum system level of integration or information need to make meaningful changes? For example, integration of hospital budgets and departments, improved linkages with community care organizations, more comprehensive case costing across the continuum of care, linked information systems to reduce repeat tests, duplication of medical histories etc.

Role Specific

- With any remaining time, interviewers were instructed to ask the participants for additional perspective on the innovation process and more detail about how their role is involved. For example, In their role, how do they view the innovation process? How do new ideas come to them and where do they go to further them?

Box B2: Online Workshop Survey Questions

- What are the most important drivers that enable hospital innovation?
- If you could implement one provincial government policy change to improve hospitals' ability to innovate, what would you do?
- Please share lessons learned from your own experiences implementing process change or adopting new technologies.

Follow-up Questions: post-event ranking of initial results and additional suggestions for potential interview participants.

- How would you rank the following barriers to innovation? Most important to least important
  - Limited system integration (patient records, data, innovation along care continuum involves many organizations, institutions and budgets)
  - Funding Silos: interdepartmental, government budgets, etc.
  - Status quo rigidity - risk aversion, resistance to disrupting existing systems.
  - Lack of financial and human resources to dedicate to change management
  - Rigid funding and HR structures limiting flexibility in deployment of resources
  - Bureaucratic Procurement Processes
- How do you rank the following drivers of innovation? Most important to least important
  - Integrated data systems to measure status quo outcomes and measure potential improvements
  - Clear value proposition (real-world evidence of cost savings or improved outcomes)
  - Executive leadership engagement
  - Funding incentives - public/private risk sharing, pay-for-performance, activity-based funding, etc.
  - Clinician support for process or technology change

Note that for the ranking questions, options were presented to participants in an individually randomized order. They are presented here in the rank-order selected by workshop participants. Ranking weights were not included in the main analysis due to a high number of partial responses and few responses relative to other data generation methods.

Online Appendix B: Examples of Successful Innovation Initiatives

The interviews asked participants if they had success stories to share from their experiences implementing innovative processes or new technologies in hospital settings. Their strategies and experiences provide contextual information about the factors that lead to success, and the challenges that need to be overcome along the way. This section includes summarized case studies selected from innovative initiatives sourced from the qualitative interview participants, including organizational reform to optimize care delivery and resources, innovative surgical techniques, and strategic initiatives to facilitate innovation.

Case Study 1: Addressing Gaps in Cardiac Care Referral Systems – Vancouver Implementation Study

The Problem: A significant challenge has emerged in managing severe cardiac valve conditions, such as aortic stenosis and mitral regurgitation, due to a critical gap in the referral pathway for affected patients. Research in Vancouver indicated that untreated valve disease has a mortality rate of 25-50 percent within two years of diagnosis.

Strategic Intervention: The Vancouver implementation study modified echo lab protocols to mandate that diagnoses of severe aortic stenosis or mitral regurgitation be highlighted with automatic referral recommendations to the Heart Team. This aimed to streamline the pathway from diagnosis to specialist care, ensuring specific contact information for referrals is provided.

Outcome Analysis: Preliminary data showed only 61 percent of eligible patients received appropriate referrals, leaving 39 percent unreferred despite clinical indications. The mortality outcomes were stark: unreferred patients faced a 19 percent mortality rate within one year, compared to just 1.8 percent for those referred. This highlights the necessity of proper referral pathways in cardiac care.

Implementation Challenges: Key challenges included capacity constraints due to increased patient identification and perceived complexity in the referral process, despite a single-point system. These issues suggest deeper systemic barriers beyond the procedural changes.

Future Directions and Policy Implications: The findings prompted a broader investigation across eight sites in Canada and the US, led by Heart Valve Voice Canada to analyze referral barriers. Three critical areas for policy intervention were identified:

1. Clinical Education and Training: Enhanced training for general practitioners and community cardiologists.
2. Resource Allocation: Improved funding mechanisms to boost cardiac care capacity.
3. Stakeholder Engagement: Inclusion of patient advocacy in policy development. The study emphasizes that effective policy change requires strategic stakeholder engagement and collaborative solution development, addressing both technical and human factors in healthcare delivery.

Case Study 2: Remote MRI Operation Implementation Barriers in Canadian Healthcare

Problem Statement: Siemens Healthineers has developed a multi-vendor remote MRI scanning technology to support scan procedures remotely. This technology enables in-house expertise to be shared across locations, allowing experts to guide on-site technologists at remote sites through exams on up to three scanners simultaneously. In addition to addressing wait time challenges, this innovation enhances knowledge transfer by enabling certified technologists to operate systems in remote locations offering better access to care. Despite its potential to expand diagnostic capacity by reducing on-site labour without compromising quality, the technology faces significant adoption barriers within the Canadian healthcare system.

Implementation Analysis: Union requirements mandating two on-site technologists effectively neutralized the efficiency gains of remote operation. This resistance, codified in both union contracts and professional guidelines, exemplifies how established protocols can impede technological innovation. The scenario reflects broader adoption challenges in Canadian healthcare, illustrated by Siemens' Healthineers tiered product strategy (M1 through M4). While Canadian institutions express interest in premier systems, funding constraints typically result in mid-tier system adoption, contrasting with European healthcare systems that more readily implement advanced technology.

Structural Barriers: The fragmented nature of Canadian healthcare funding emerges as a critical impediment. Capital equipment funding flows through separate government entities from operational healthcare budgets, creating misaligned incentives. In Alberta, British Columbia, and Quebec, equipment procurement decisions rest with infrastructure or financial entities separate from healthcare operations, prioritizing cost containment over healthcare delivery optimization. Leading academic centers circumvent these limitations through foundation support and donor contributions, though this creates geographical and institutional disparities in access to innovative solutions.

Policy Framework: Addressing these systemic barriers requires integrated reform of capital funding mechanisms to align with healthcare delivery objectives, development of flexible workforce policies maintaining safety standards while enabling innovation, and creation of hub-and-spoke models extending academic centers' technical expertise to community hospitals. This implementation challenge demonstrates how funding structures, labour agreements, and institutional policies can collectively impede beneficial healthcare innovations, necessitating systematic policy realignment to effectively support technology adoption.

The case illustrates the complex interplay between innovation potential and systemic constraints in Canadian healthcare, highlighting the need for coordinated policy reform to enable technological advancement, while maintaining equitable access to advanced diagnostic capabilities across Canada's geography. The concentration of advanced technology in major academic centers, particularly in institutions like the University Health Network, underscores the urgency of developing more distributed models of technology implementation.

Case Study 3: Transforming Healthcare Delivery Through Extensivism at South Lake Health

Problem Statement: South Lake Health, formerly South Lake Regional Health Center, faces significant healthcare delivery challenges representative of broader systemic issues in Ontario and across Canada. The institution confronts severe capacity constraints, with patients housed in emergency department hallways and with multiple overflow areas in operation. This situation reflects two fundamental challenges: aging, undersized infrastructure and pronounced geographic disparities in healthcare utilization. The disparity is particularly evident in bed utilization rates, with one geographic area showing nearly double the bed days per 1,000 residents compared to another, highlighting significant variations in healthcare access and outcomes across the 1,200 square kilometer catchment area.

Strategic Solution: The institution has developed an innovative approach centered on "extensivism," a concept adapted from American Accountable Care Organizations' value-based reimbursement models. This strategy operates on three primary interventions: hospital replacement care, hospital avoidance through virtual care, and advanced chronic disease management for comorbid patients. The approach is founded on population health management principles, utilizing risk stratification to identify and manage high-risk, high-cost patients more effectively. The extensivism program, scheduled for implementation in January 2025, includes establishing dedicated clinics and hospital-at-home services to bridge the gap between primary care and acute services. A critical factor is the integration of patient flows between hospital, home, and clinic care, as well as improved chronic disease management.

Target Outcomes and Measurement: Success will be measured through several key metrics, primarily focusing on population health indicators and resource utilization. The primary metric is the reduction in bed days per 1,000 residents, particularly in high-utilization areas like Georgina. The strategy aims to push up the percentage of healthy population while simultaneously reducing the proportion requiring acute and specialty care. This transformation should be reflected in decreased emergency department utilization, reduced length of stay, and improved management of chronic conditions in community settings.

Implementation Challenges: The initiative faces several significant barriers to successful implementation. First, the current funding model in Ontario, described as fragmented and contradictory, poorly aligns with population health management approaches. The strategy requires risk-adjusted capitated payments rather than the existing procedure-based funding structure. Second, physician engagement and alignment present challenges, as the current system lacks effective mechanisms for integrating physician incentives with population health goals. Third, governance structures under the *Public Hospitals Act* may impede system-wide optimization, potentially creating "tragedy of the commons" scenarios where individual institutional interests conflict with broader system benefits. Finally, the underdevelopment of primary care infrastructure means that extensivism must temporarily fill roles ideally suited for enhanced primary care services, requiring careful management of this transition over the next decade.

This case study illustrates an ambitious attempt to transform healthcare delivery through population health management principles. Its success could provide a scalable model for addressing similar challenges across Ontario and beyond, though significant policy and structural changes would be required for optimal implementation.

Case Study 4: Trillium Health Partners' Telerounding Program with Maple Technology

The Problem: Residents of long-term care homes are high-volume users of emergency department and hospital services, They are also more likely to have chronic conditions, such as COPD, and to be ALC patients.

Intervention: In 2020, Trillium Health Partners (THP) launched a two-year Telerounding Program, facilitated by Maple technology, to improve long-term care (LTC) patient outcomes and manage emergency department (ED) visits. The LTC initiative deployed integrated virtual care bedside terminals (IBTs) to long-term care homes, enabling "immediate" virtual care consultations. The ED Diversion program was staffed by participating hospitals' internists as the main consultants, who had the ability to refer to other hospital specialties as needed. The program was integrated into six LTC homes and supported 10 specialty areas, including neurology, palliative care, and geriatrics.

Implementation Results: The ED Diversion program was available across Mississauga Hospital, Credit Valley Hospital, and Queensway Health Centre. Through the program, 70 percent of virtual consultations on the Maple platform prevented a hospital visit or an emergency department transfer. In its first year alone, it facilitated over 800 virtual consultations, ultimately preventing high-risk ED transfers. Subsequently, THP and Maple allowed for integrated rounding days for other specialties. Initially driven by the COVID-19 crisis, the program proved to be an effective tool in enhancing care access, reducing hospital strain, and modernizing healthcare delivery in the LTC setting. Despite its success, the program was discontinued due to fragmented funding structures. The services were occurring in the community and thus did not fit into the hospital funding model. The lack of a sustainable funding model for a hospital to care for patients in the community meant there was little institutional capability to sustain it. This barrier, rather than the program's effectiveness, ultimately led to its closure.

The cancellation of THP's Telerounding Program represents a missed opportunity for virtual care advancement and hospital innovation. With proper funding and integration, it could have set a precedent for telehealth in long-term care settings. Instead, it highlights a recurring challenge in healthcare innovation – proven solutions struggle to survive due to a lack of sustainable investment and strategic commitment.