
A Canadian Healthcare Policy Framework for Clinical Care at the End and the Beginning of Life: Prioritization, Human Resource Management, and Remuneration Models

R Douglas Wilson MD MSc FRCSC

Abstract

The Canadian health-care system requires re-evaluation and innovation focused on clinical services provided at the beginning of life. The provincial/ territorial healthcare systems have not ethically prioritized clinical services, nor provided sustainable human resource management, or appropriate fiscal remuneration directed at healthcare providers serving patients at the beginning of life. Senior care has been prioritized for decades, but the beginning of life offers the greatest opportunities to make a positive long-term impact on population health outcomes. Investing in improving the health of Canadians at the beginning of life will lead to lower overall healthcare costs later in life. Ethically based prioritized healthcare services are required for both the end and the beginning of life populations. Sustainable human resources, cost-effective care, appropriate remuneration, and timely access with outcome-accountable healthcare service is required.

Affiliations: Professor Emeritus Department of Obstetrics and Gynecology; Cumming School of Medicine University of Calgary, Calgary, Alberta, Canada

Correspondence: doug.wilson@ahs.ca

Disclosure: artificial intelligence was not used, and no funding was received for the production of this article.

Open access sponsor: none.

Publisher: Canadian Health Policy Institute Inc. www.chpi.ca

Status: Peer reviewed.

Submitted: 22 FEB 2024. Resubmitted: 1 MAY 2024. Published: 02 JUL 2024.

Citation: Wilson, R Douglas (2024). A Canadian Healthcare Policy Framework for Clinical Care at the End and the Beginning of Life: Prioritization, Human Resource Management, and Remuneration Models. *Canadian Health Policy*, JUL 2024. <https://doi.org/10.54194/DDMO2827>. canadianhealthpolicy.com.

Introduction

There are two clinical care groups, people at the ‘end of life’ (65 years of age and older) and people at the ‘beginning of life’ (0 to 19 years of age), that require prioritization in Canada’s health policies. According to the most recent data from Statistics Canada, Canada’s total population was reported to be approximately 40.1 million people in 2023. It is estimated that there were 7.6 million Canadians with potential ‘end of life’ care needs (18.9% of the national population) and over 8.4 million Canadians with potential ‘beginning of life’ care needs (21% of the national population). **[TABLE 1]**

TABLE 1. CANADA POPULATION AND GOVERNMENT HEALTH EXPENDITURE ESTIMATES BY AGE GROUP

<u>AGE GROUPS</u>	<u>* POPULATION</u>	<u>** TOTAL PROV/TERR HEALTHCARE SPENDING (\$ millions)</u>
0 to 4 years	1,881,497	\$9,483.20
5 to 9 years	2,122,845	\$4,648.60
10 to 14 years	2,187,154	\$5,170.70
15 to 19 years	2,233,251	\$5,983.70
20 to 24 years	2,616,655	\$7,070.10
25 to 29 years	2,907,754	\$8,888.70
30 to 34 years	2,976,658	\$10,074.00
35 to 39 years	2,808,843	\$9,725.10
40 to 44 years	2,674,762	\$9,125.20
45 to 49 years	2,456,827	\$9,365.50
50 to 54 years	2,430,257	\$11,034.30
55 to 59 years	2,550,386	\$13,991.60
60 to 64 years	2,682,564	\$15,881.30
65 to 69 years	2,381,063	\$17,581.70
70 to 74 years	1,912,789	\$18,167.80
75 to 79 years	1,459,513	\$16,319.80
80 to 84 years	918,411	\$14,428.20
85 to 89 years	540,554	\$13,933.00
90 to 94 years	266,869	\$11,071.6
95 to 99 years	77,404	
100 + years	11,705	
All ages	40,097,761	\$211,944.20
0 to 19 years	8,424,747	\$25,286.2
65+ years	7,568,308	\$91,502.1

* Statistics Canada. Table 17-10-0005-01. Population estimates on July 1, 2023 by age and gender.

** Canadian Institute for Health Information. National Health Expenditure Trends Database. Table E.1.24.1 Estimate of total provincial/territorial government health expenditures by age and sex in millions of current dollars, by province/territory and Canada, 2021.

According to the Canadian Institute for Health Information, the most recent data published on health expenditure by age indicated that in 2021, more than 43% (\$91.5 billion) of total healthcare spending by provincial/ territorial governments (\$211.9 billion) was directed toward the medical needs of those aged 65 years and older, while less than 12% (\$25.3 billion) was spent on people aged 19 years and younger. Adjusting for the size of the cohort populations, provincial/ territorial government healthcare spending per capita was \$3001 for the age group 0 to 19 years versus \$12,091 for the 65 and older age group. **[TABLE 1]** As baby boomers (people born between 1946-1965) enter senior years it is expected that medical resources will shift proportionally further toward the services used for care provided at the end of life.

This paper argues that there are economic reasons to prioritize the health care needs of people at the beginning of life. The relative distribution of healthcare resources is important because technological advances are creating the opportunity for significant health gains from early treatment of diseases identified at the beginning of a patient's life cycle. The increasing use of genomic medicine has presented a new clinical opportunity to screen, diagnose, and treat genetic diseases. Prioritizing 'beginning of life' services will require increased knowledge transfer regarding the relevant health issues and a better public understanding of the most effective use of public healthcare dollars. [1-5]

Opportunities to improve population health at the beginning of life

There are numerous opportunities to improve clinical outcomes for the 'beginning of life' cohort, especially regarding pregnancy related maternal and neonatal morbidity and mortality [6]. There are important social, ethical, and cost considerations for the use of evidenced-based maternal-fetal-neonatal genetic screening, neonatal (fetal) gene therapy, maternal-fetal surgery, and extreme preterm birth neonate treatment (morbidity reduction) options. There is a lack of comprehensive and multidisciplinary reproductive care programs in the following areas:

- maternal (paternal) genetic carrier screening (preconception risk prediction; antenatal identification of fetal genetic disease; triage for neonatal treatment options) [7, 8]
- prenatal chromosomal and genomic diagnostic testing and potential treatment [9-20]
- maternal obstetrical screening to prevent / moderate severe hypertensive disorders of pregnancy (early onset pre-eclampsia); maternal screening for preterm birth, with risk prediction and treatment / management [9, 21-30]
- maternal-fetal surgery for complex fetal anatomical malformations; new innovative neonatal treatment programs and options (ex utero aqueous support systems for the treatment of the extreme preterm delivery (22-24 weeks) [10, 31-35]
- genomic sequencing (GS) technology has created a significant clinical opportunity for novel molecular identification for increasing numbers of monogenic disorders. [36-42]
- The provision of quality and safe maternity care services requires '24/7' multi-disciplinary service support but the fiscal support for these reproductive quality and safety services is variable from provincial and territorial health-care administrations. A program-based or salary remuneration for 'on-site' human resource obstetrical labour delivery coverage is required to eliminate the multiple and often simultaneous labor delivery risks with a single obstetrical specialist provider using fee-for-service models. Hospital-based maternity 'risk assessment' triage units are co-located with the labor delivery unit but the emergency services are not funded or supported in a manner similar to the hospital-based emergency department standard.
- Efficient and available maternal and neonatal transport systems are impacted by problematic ground-based ambulance transport systems in many Canadian regions, while the air-based transport has geographic and weather barriers.
- The implementation of protocol-based surgical care programs such as Enhanced Recovery after Surgery (ERAS) and National Surgical Quality Improvement Program (NSQIP) are required as caesarean delivery is the leading

indication for abdominal surgery in the developed world. NSQIP is effective for directed surgical quality improvement and reducing surgical morbidity. NSQIP programs for Surgery in British Columbia and Alberta could support the opportunity and requirements for obstetrical oversight implementation [43-51].

- There are more than 800 cell and gene therapies in clinical development [52-58]. There will be increased demand for preconception or antenatal clinical genetic carrier screening programs for parental-fetal and neonatal risk management, gene therapy counselling, access, and innovation [7, 8]. Genomic treatment costs have been identified as a funding issue for family and health-care systems. These innovative therapies, lead to new treatments, for diseases that formerly lacked any therapeutic agents. The fiscal challenge in cell and gene therapies is that these one time, high-cost treatments are being introduced into a reimbursement process created for medicines with a continued long-term clinical use and cost. A single-administration treatment, given similar outcomes should be preferable to repetitively administered drugs. Therefore, the long-term benefit for one-time therapies is the justification for the anticipated high one-time cost. [52].
- Children with complex needs represent almost 1% of children (80,000 children in Canada). An additional 2-3% children are born with major congenital anomalies (isolated or multiple) with variable complexity based on the anatomical system involved. The medical lack of family support for these children is a large failure as family tax-benefits are not enough.

Clinical Care Prioritization Process

This health policy framework is advocating the evidenced-based continuation for the ‘end of life’ care and a necessary fiscal expansion for the ‘beginning of life’ care. The use of the prioritized healthcare service will support and maintain the presently funded *non-preventive* clinical ‘end of life’ services but will allow for improved decision making on the provided services and their value. Expansion for ‘the beginning of life’ clinical service (new or re-allocated funding) will require the evaluation of the new genomic as well as the traditional diagnostic and treatment processes, using an ethically-based review to evaluate prevention and enhanced management opportunities for reduction of maternal-fetal-neonatal morbidity and mortality.

One administrative process is to prioritize the required service needs for each of the broad clinical-surgical categories using appropriate ethical and health outcome considerations. The Oregon model (known as the Oregon Health Plan or OHP) was developed in 1989, to use a prioritized list of health services to determine the benefits available to Oregon's Medicaid clients. Public healthcare spending priorities are ranked based on the importance of the clinical area with the measure of the service impact (enhancement for healthy living, impact on suffering, public population health, population vulnerability, tertiary prevention), evidenced-based service effectiveness, and the clinical need for the service. The 2024 OHP Prioritized List contains 660 line-items consisting of condition-treatment pairs with a high emphasis on preventive services and chronic disease management as these services can lead to a reduction in more expensive and often, less effective treatments provided in the later stages of disease. The OHP reviews the Prioritized List every two years and makes additional modifications re-new medical codes, correct technical errors, and reflect medical advancements twice a year. [TABLE 2] [59]

Human Resource Management

The Canadian House of Commons Health Committee has reported on Canada's present health workforce crisis [62]. Physician workforce planning must consider the aging population and the trend for decreased physician hours of work. While the Canadian ‘physician to population’ ratio (PPR) has increased (1987- 2019 35% higher), the delayed access barrier for patients continues. The PPR ratio is no longer a useful tool as more post-graduate training positions will be required to meet the clinical and physician demand [63, 64]. Quebec's health-care workforce planning process has been successful as it matches an identified regional-hospital-based clinical and service employment requirement with a trainee and residency position.

TABLE 2. OREGON HEALTHCARE PRIORITIZATION FRAMEWORK

CATEGORY WEIGHT DEFINITIONS (CONSENSUS WEIGHTED SCORE)	POPULATION AND INDIVIDUAL IMPACT MEASURES DEFINITIONS
<ul style="list-style-type: none"> • Maternity & Newborn Care (100) - Obstetrical care for pregnancy. Prenatal care; delivery services; postpartum care; newborn care for conditions intrinsic to the pregnancy. • Primary Prevention and Secondary Prevention (95) - Effective preventive services used prior to the presence of disease and screenings for the detection of diseases at an early stage. Immunizations; fluoride treatment in children; mammograms; pap smears; blood pressure screening; well child visits; routine dental exams. • Chronic Disease Management (75) - Predominant role of treatment in the presence of an established disease is to prevent an exacerbation or a secondary illness. Medical therapy for diabetes mellitus, asthma, and hypertension. Medical/psychotherapy for schizophrenia. • Reproductive Services (70) - Excludes maternity and infertility services. Contraceptive management; vasectomy; tubal occlusion; tubal ligation. • Comfort Care (65) - Palliative therapy for conditions in which death is imminent. Hospice care; pain management. • Fatal Conditions, Where Treatment is Aimed at Disease Modification or Cure (40) - Appendectomy for appendicitis; medical & surgical treatment for treatable cancers; dialysis for end-stage renal disease; medical therapy for stroke; medical/psychotherapy for single episode major depression. • Nonfatal Conditions, Where Treatment is Aimed at Disease Modification or Cure (20) - Treatment of closed fractures; medical/psychotherapy for obsessive-compulsive disorders; medical therapy for chronic sinusitis. • Self-limiting conditions (5) - Treatment expedites recovery for conditions that will resolve on their own whether treated or not. • Inconsequential care (1) - Services that have little or no impact on health status due to the nature of the condition or the ineffectiveness of the treatment. 	<ul style="list-style-type: none"> • Impact on Healthy Life - What is the magnitude of the benefit to the patient from the treatment as compared to no treatment for the condition, after factoring in harms associated with the treatment. Range of 0 (no impact) to 10 (high impact). • Impact on Suffering - To what degree does the condition result in pain and suffering? Effect on family members (dealing with Alzheimer's disease or the need to care for a person with a life-long disability) is factored in here. Range of 0 (no impact) to 5 (high impact). • Population Effects - The degree to which individuals other than the person with the illness will be affected (public health concerns due to the spread of untreated infections or public safety concerns resulting from untreated severe mental illness). Range of 0 (no effects) to 5 (widespread effects). • Vulnerability of Population Affected - To what degree does the condition affect vulnerable populations such as those of certain racial/ethnic descent or those afflicted by certain debilitating illnesses (HIV disease; alcohol and drug dependence). Range of 0 (no vulnerability) to 5 (high vulnerability). • Tertiary Prevention – For considering the ranking of services within new categories 6 and 7, to what degree does early treatment prevent complications of the disease (not including death)? Range of 0 (doesn't prevent complications) to 5 (prevents severe complications). • Effectiveness - To what degree does the treatment achieve its intended purpose? Range of 0 (no effectiveness) to 5 (high effectiveness). • Need for Medical Services - The percentage of time in which the medical services would be required after the diagnosis has been established. Percentage from 0 (services never required) to 1 (services always required).

Oregon: Prioritized List of Health Services Methodology - Developed by the Health Services Commission (HSC) *Updated 1/2/2018.*

Human resources planning for medical doctors is more complex regarding length of training, type of clinical/ surgical work, hospital privilege, academic/ community practice locations, urban/rural populations, and professional access to needed clinical resources (emergency room; operating room; laboratory and imaging services). Patterns of practice are shifting from the 'solo' small business model to larger medical groups, with vertical and horizontal integration into larger hospital systems/ services. These larger groups have increased complexity for workplace finance, provider payment, and delivery of care models [65]. The emerging significance of generational lifestyle differences should not be underestimated in human resource planning. [66]

In nursing, the human resources loss is estimated to be 16% (2023/ 40,700 nursing vacancies) with an additional 117,000 nurses, predicted by the end of the decade. The nursing work environment, with high patient workloads, lack of supportive resources, mandatory overtime requirements, and their fear for personal safety, has resulted in many nurses leaving the profession. [67]

Human resources for all professional services require a long-term provincial (with national consideration) planning process using appropriate need projections for professional training requirements (MD, nursing, health associated professions); multiple coordination and support for post-secondary training institutions; national labour mobility for health workers via multi-jurisdictional credential recognition, and an enhanced process for screening, evaluation, oversight, and placement of foreign-trained health-care professionals. Provinces such as British Columbia and Nova Scotia have used international recruitment for nursing, physicians (UK), and emergency paramedics (Australia). [68]

Estimated healthcare provider human resource and service needs for the end and beginning of life should include:

1. defining the clinical and social service need; the required scope of practice; an estimated number of professional services for the clinical cohort, fiscal and outcome-based tools to measure the accountability for access, clinical quality and safety, and patient's satisfaction.
2. Identifying the number of clinical providers required for the identified service needs; human resource management planning; designation of full-time equivalents (FTE) projections with the provider accountability criteria and categories; the educational training requirements; assessment of the clinical service impact: annual outcome / impact assessment with audit and provider feedback; a required process for clinical revision / correction as identified.
3. identify the number and location for service locations; service scope (patient centered; urban; regional; rural); the service -based budget estimates (re-allocation, new; service review).
4. Expanded human resource training and support for the 'beginning of life' providers would be required for the expansion and service delivery requirements at urban obstetric and pediatric centers and in regional and rural locations, in Canada.

Remuneration Support Models

Remuneration models are an important fiscal factor for the provider clinical service models or practice options as well as the healthcare system. [69-76] Policy should support alternate payment models. The fee for service model has limited value except for selected evidenced-based routine clinical scenarios. Gender-based differences have been identified within the fee-for-service remuneration model. [77, 78]

The present amount of federal and provincial healthcare funding contributions and the continuing CHT contributions should be considered adequate, for this discussion. There is likely a significant number of operating losses from process inefficiency, administrative redundancy, poor clinical care (inappropriate/ ineffective/ redundant), repetitive care due to poor quality and outcomes (partially due to lack of clinical accountability), provider funding models with limited oversight for fiscal outliers, and the restriction for the use of expanded scope of practice by other health professionals.

The development of a remuneration model that follows a clinically ethical, equitable, clinically cost-effective, cost-appropriate salary with provider accountability, patient outcome satisfaction, and balanced patient, provider, and funder service needs should be the goal for an innovative and reactive healthcare system.

Provincial healthcare support for reproductive and pediatric services have been a lower clinical priority for infrastructure; reproductive screening, and provider remuneration. The Alberta Medical Association initiated an Income Equity evaluation and identified that funding allocations had been lower for providers in obstetrics and gynecology, pediatrics, psychiatry, neurology, and family medicine. Four (O/G; Ped; Psych; FM) of these five clinical provider groups are required for 'the beginning of life' services [79]. Provincial collaborative peri-natal care programs are supported for organizational and data collection mandates but there is no fiscal support for quality improvement or implementation of evidenced-based services [9, 79-81].

Three remuneration system changes are required: equitable employee or alternate payment contracts, use of a well-defined and evidenced 'relative-value fee guide' process with provider accountability. An appropriate healthcare service management system (service audit, review, provider feedback, service change as required) is needed for cost-effective fiscal management over the clinical service and provider. Alternate payment models or principles would replace the presently dominant 'fee -for-service' funding model. The newer medical graduates have indicated a preference for contract service remuneration models with designated FTE, administrative support, work-place benefits, and pension contributions rather than the 'small medical business owner' model.

Opportunities have been proposed to create larger family physician workforces, by providing interprofessional team-based care associated with new funding models, these concepts are recycled for urban and rural 'neighbourhood-based' clinics with employed and accountable physicians and resource efficient regionally organized 'out of hours' care centers [82, 83]. Similar concepts would be required for the clinical services provided by community-based specialists and hospital-required physicians and surgeons. The 'big picture' should support an adaptive and progressive healthcare system that is accessible, efficient, safe, and accountable but using a patient and provider-focused culture approach.

Capital investment needs

Capital expense planning for enhanced co-location of maternal, obstetric, neonatal, and pediatric services would be required. Capital investment (new or revised capital structure planning) requires complex long-term prediction of population, location, and finances, along with the continuity and changing clinical and technical service needs. There are important differences for urban and rural based capital needs as part of the business planning.

Conclusion

The necessity for clinically prioritized services in Canada is required, using ethical, cost-effective, cost-appropriate, outcome accountable healthcare service implementation and on multiple levels: ethical-outcome based ethical prioritization of clinical services; greater prevention/ public health focus, re-structured service models (team-based services); alternate payment or salary based FTE remuneration models for MDs; and human resource planning and management for all levels of health professional providers.

References

1. Measures to Address Health System Challenges. Review of Canadian, Provincial, and Territorial 2022 Budgets September 2022 CMA / Deloitte; p1-27.
2. Picard A. The premiers need to get serious about health care reform, not just funding. Globe and Mail. Health Opinion. July 10, 2023.
3. Globe Content Studio. Why CMA is taking on public and private health care in Canada. Globe and Mail August 29, 2023.
4. After a 'decade of decline' in health care, Canadians not convinced that money is enough to solve the crisis. <https://angusreid.org/cma-health-care-access-priorities-2023/>
5. Picard A. Survey says: Improve access to health care-now. Globe and Mail. Health. August 21, 2023.
6. BORN Ontario. <https://www.bornontario.ca/about-born>. Accessed September 2023
7. Wilson RD. Perinatal Genetic Carrier Screening: Could a sequential perinatal carrier screening approach be a better way? Int J Obstet Gynecol. 2023; 11(5): 001-0028; ISSN 2736-1594; www.internationalscholarsjournals.org.
8. Richardson E, McEwen, Newton-John T, Jacobs C. Defining core outcomes of reproductive genetic carrier screening: A Delphi survey of Australian and New Zealand stakeholders. Prenat Diagn 2023; 43: 1150-1165; doi: 10.1002/pd.6410
9. Wilson RD. The Real Maternal Risks in a Pregnancy: A Structured Review to Enhance Maternal Understanding and Education. J Obstet Gynaecol Can 2019; <https://doi.org/10.1016/j.jogc.2019.12.005>
10. Al-Refai A, Ryan G, Van Mieghem T. Maternal risks of fetal therapy. Curr Opin Obstet Gynecol 2017; 29: 80-84; doi: 10.1097/GCO.0000000000000346
11. Zhu Z, Lei D, Qin K, Li W, Tallman MJ, Patino R, et al. Brain network structural connectome abnormalities among youth with attention-deficit / hyperactivity disorder at varying risk for bipolar I disorder: a cross-sectional graph-based magnetic resonance imaging study. J Psychiatry Neurosci. 2023; 48(4): E315; doi: 10.1503/jpn.220209
12. Wynn J, Hoskovec J, Carter RD, Ross MJ, Perni SC. Performance of single-gene noninvasive prenatal testing for autosomal recessive conditions in a general population setting. Prenat Diagn 2023; 43: 1344-1354; doi: 10.1002/pd.6427
13. Adams S, Llorin H, Dobson LJ, Studwell C, Wilkins-Haug L, Guseh S, Gray KJ. Postnatal genetic testing on cord blood for prenatally identified high-probability cases. Prenat Diagn 2023; 43: 1120-1131; doi: 10.1002/pd.6352
14. Xiang L, Zhu J, Deng K, Li Q, Tao J, Li M, et al. Non-invasive prenatal testing for the detection of trisomies 21, 18, and 13 in pregnant women with various clinical indications: A multicenter observational study of 1,854,148 women in China. Prenat Diagn 2023; <https://doi.org/10.1002/pd.6312>
15. Ge Y, Li J, Zhuang J, Zhang J, Huang Y, Tan M, et al. Expanded noninvasive prenatal testing for fetal aneuploidy and copy number variations and parental willingness for invasive diagnosis in a cohort of 18, 518 cases. BMC Med Genomics 2021; 14: 106; <https://doi.org/10.1186/s12920-021-00955-6>
16. Miceikaite I, Fagerberg C, Brasch-Andersen C, Topping PM, Kristiansen BS, Hao Q, et al. Comprehensive prenatal diagnostics: Exome versus genome sequencing. Prenat Diagn 2023; 43: 1132-1141; doi: 10.1002/pd.6402
17. Zhou J, Yang Z, Sun J, Liu L, Zhou X, Liu F, et al. Whole Genome Sequencing in the Evaluation of Fetal Structural Anomalies: A Parallel Test with Chromosomal Microarray Plus Whole Exome Sequencing. Genes 2021; 12: 376; <https://doi.org/10.3390/genes12030376>

18. Hayeems RZ, Bhawra J, Tsiplova K, Meyo MS, Monfared N, Bowdin S, et al. Care and cost consequences of pediatric whole genome sequencing compared to chromosomal microarray. *Euro J Human Genetics* 2017; 25: 1303-1312; <https://doi.org/10.1038/s41431-017-0020-3>
19. Salomon IJ, Sotiriadis A, Wullf CB, Odibo A, Akolekar R. Risk of miscarriage following amniocentesis or chorionic villus sampling: systematic review of literature and updated meta-analysis. *Ultrasound Obstet Gynecol* 2019; 54: 442-451; doi: 10.1002/uog.20353
20. Jenkins M, Seasely AR, Subramaniam. Prenatal genetic testing: diagnostic tests. *Curr Opin Pediatr* 2022; 34: 553-558; doi: 10.1097/MOP.0000000000001174
21. Clark SL, Saade GA, Tolcher MC, Belfort MA, Rouse DJ, Barton JR, et al. Gestational hypertension and “severe” disease: time for a change. *Amer J Obstet Gynecol* 2023; 228(5): 547-552; <https://doi.org/10.1016/j.ajog.2022.11.1280>
22. Varner CE, Ray JG. Addressing fragmented early pregnancy screening in Canada. *CMAJ* 2023; 195: E15555-6; Doi: 10.1503/cmaj.231568
23. Jain V, Bujold E. Screening for preeclampsia risk and prophylaxis with acetylsalicylic acid. *CMAJ* 2023; 195: E1557-8
24. Hochler H, Lipschuetz M, Suissa-Cohen Y, Weiss A, Sela HY, Yagel S, et al. The Impact of Advanced Maternal Age on Pregnancy Outcomes: A Retrospective Multicenter Study. *J Clin Med.* 2023; 12:5696; <https://doi.org/10.3390/jcm12175696>
25. Chappell LC, Clover CA, Kingdom J, Tang S. Pre-eclampsia. *Lancet* 2021; <https://doi.org/10.1016/S0140-6736920032335-7>
26. Raineau M, Deneux-Tharoux C, Seco A, Bonnet MP. Antepartum severe maternity morbidity: A population-based study of risk factors and delivery outcome. *Pediatr Perinat Epidemiol.* 2022;36: 171-180; Doi: 10.1111/ppe.12847
27. Inder TE, Volpe JJ, Anderson PJ. Defining the Neurologic Consequences of Preterm Birth. *N Engl J Med* 203: 389: 441-53; doi: 10.1056/NEJMra2303347
28. Bloomfield V, Rogers S, Leyland N. Placenta accreta spectrum. *CMAJ* 2020; 192: E980; doi: 10.1503/cmaj.200304
29. Stanley KE, Giordano J, Thorsten V, Buchovecky C, Thomas A, Ganapathi M, et al. Causal Genetic Variants in Stillbirth. *N Engl J Med* 2020; doi: 10.1056/NEJMoa1908753
30. Merc MD, Peterlin B, Lovrecic L. The genetic approach to stillbirth: A systematic review. *Prenat Diagn* 2023; 43: 1220-1228; doi: 10.1002/pd.6354
31. Baumgarten HD Flake AW. Fetal Surgery. *Pediatr Clin N Am.* 2019; 66:295-308; <https://doi.org/10.1016/j.pcl.2018.12.001>
32. Moldenhauer JS, Flake AW. Open fetal surgery for neural tube defects. *Best Practice & Research Clinical Obstetrics and Gynaecology* 2019; 58: 121-132; <https://doi.org/10.1016/j.bpobgyn.2019.03.004>
33. Danzer E, Joyeux L, Flake AW, Deprest J. Fetal surgical intervention for myelomeningocele: lessons learned, outcomes, and future implications. *Developmental Med & Child Neurology* 2020; 62: 417-425
34. Anriël RM, Flake AW, Collura CA, Johnson MP, Rintoul NE, Lantos JD, et al. Weighing the Social and Ethical Considerations of Maternal-Fetal-Surgery. *Pediatrics* 2017; 140(6): e20170608
35. Flake AW, De Bie FR, Munson DA, Feudtner C. The artificial placenta and EXTEND technologies: one of these things is not like the other. *J Perinatology* 2023; <https://doi.org/10.1038/s41372-023-01716-2>
36. Collins F, Doudna JA, Lander ES, Rotimi CN. Human Molecular Genetics and Genomics – Important Advances and Exciting Possibilities. *N Engl J Med* 2021; 384(1): 1-4; DOI: 10.1056/NEJMp2030694
37. Posey JE, Lupski JR. Genomics in Clinical Practice. *N Engl J Med* 2023; 388: 1619-1620; doi: 10.1056/NEJMe2302643

38. Wright CF, Campbell P, Eberhardt RY, Aitken S, Perrett D, Brent S, et al. Genomic Diagnosis of Rare Pediatric Disease in the United Kingdom and Ireland. *N Engl J Med* 2023; 388(17): 1559-1571; DOI: 10.1056/NEJMoa2209046
39. 100,000 Genomes Project Pilot Investigators. 100,000 genomes pilot on rare disease diagnosis in health care — preliminary report. *N Engl J Med* 2021;385: 1868-80.
40. Adams DR, Eng CM. Next-generation sequencing to diagnose suspected genetic disorders. *N Engl J Med* 2018; 379:1353-62.
41. Lalonde E, Rentas S, Lin F, Dulik MC, Skraban CM, Spinner NB. Genomic diagnosis for pediatric disorders: revolution and evolution. *Front Pediatr* 2020; 8:373.
42. Bennett CA, Petrovski S, Oliver KL, Berkovic SF. ExACTly zero or once: a clinically helpful guide to assessing genetic variants in mild epilepsies. *Neurol Genet* 2017;3(4): e163
43. Wilson RD, Caughey AB, Macones GA, Wood SL, Wrench IJ, Huang J, et al. Guidelines for Antenatal and Preoperative Care in Cesarean Delivery: Enhanced Recovery After Surgery (ERAS) Society Recommendations (Part 1). *Am J Obstet Gynecol* 2018 Sept 18; doi: 10.1016/j.ajog.2018.09.015. PMID: 30240657
44. Caughey AB, Macones GA, Wood SL, Wrench IJ, Huang J, et al (Senior Author Wilson RD) Guidelines for Intra-Operative Care in Cesarean Delivery: Enhanced Recovery After Surgery (ERAS) Society Guidelines (Part 2) *Am J Obstet Gynecol* 2018 Aug 14; doi:10.1016/ajog.2018.08.006; PMID 30118692.
45. Macones GA, Caughey AB, Wood SL, Wrench IJ, Huang J, Norman M, Petterson K, Fawcett WJ, Shalabi MM, Metcalfe A, Gramlich L, Nelson G, Wilson RD. Guidelines for Postoperative care in Cesarean Delivery: Enhanced Recovery After Surgery (ERAS) Society Recommendations (Part 3). *Am J Obstet Gynecol*. 2019 Apr 14. doi: 10.1016/j.ajog.2019.04.012
46. Montroy J, Breau RH, Cnossen S, Witliuk K, Binnette A, Ferrier T, et al. Change in Adverse Events After Enrollment in the National Surgical Quality Improvement Program: A Systematic Review and Meta-Analysis. *PLOS One* 2016; 11(1): e0146254; doi: 10.1371/journal.pone.0146254
47. Woo RK, Skarsgard ED. Innovating for quality and value: Utilizing national improvement programs to identify opportunities for responsible surgical innovation. *Seminars in Ped Surg* 2015; 24: 138-140; <http://dx.doi.org/10.1053/j.sempedsurg.2015.02.013>
48. Schroeder D, Luig T, Beesoon S, Robert J, Campbell-Scherer D, Brindle M. What work is required to implement and sustain the National Surgical Quality Improvement Program (NSQIP)? A qualitative study of NSQIP implementation in Alberta, Canada. *BMJ Open* 2021; 11: e044720; doi: 10.1136/bmjopen-2020-044720
49. Bilimoria KY, Liu Y, Paruch JL, Zhou L, Kmiecik TE, Ko CY, Cohen ME. Development and Evaluation of the Universal ACS NSQIP Surgical Risk Calculator: A Decision Aid and Informed Consent Tool for Patients and Surgeons. *J Am Coll Surg* 2013; 217: 833-842; <http://dx.doi.org/10.1016/j.jamcollsurg.2013.07.385>
50. Tshering S, Dorji N, Lhaden K. Implementing Enhanced Recovery after Surgery in Obstetrics: Lesson from the Nationwide Lockdown. *J South Asian Federation Obstet Gynaecol*. 2021; doi: 10.5005/jp-journals-10006-1860
51. Oudit R, Biccard B, Nelson G, Ljungqvist O, Brindle ME. ERAS Society Recommendations for Improving Perioperative Care in Low and Middle-Income Countries Through Implementation of Existing Tools and Programs: An Urgent Need for the Surgical Safety Checklist and Enhanced Recovery After Surgery. *World J Surg* 2021; <https://doi.org/10.1007/s00268-021-06279-x>
52. High KA, Roncarolo MG. Gene Therapy. *N Engl J Med* 2019; 381(5): 455-464; DOI: 10.1056/NEJMra1706910
53. Peranteau WH, Flake AW. The Future of In Utero Gene Therapy. *Mol Diagn Ther* 2020; 24(2): 135-142; DOI: 10.1007/s40291-020-00445-y
54. George LA. Hemophilia A Gene Therapy—Some Answers. More Questions. *N Engl J Med* 2023; doi: 10.1056/NEJMe2212347

55. Mahlangu J, Kaczmarek R, von Drygalski A, Shapiro S, Chou S-C, Ozelo MC, et al. Two-Year Outcomes of Valoctocogene Roxaparvovec Therapy for Hemophilia A. *N Engl J Med* 2023; 388: 694-705; doi: 10.1056/NEJMoa2211075
56. Pipe SW, Leebeek WG, Recht M, Key NS, Castaman G, Miesbach W, et al. Gene Therapy with Etranacogene Dezaparvovec for Hemophilia B. *N Engl J Med* 2023; 388: 706-18; doi:10.1056/NEJMoa2211644
57. Sharma A, Boelens J-J, Cancio M, Hankins JS, Bhad P, Azizy M, et al. CRISPR-Cas9 Editing of the HBG1 and HBG2 Promoters to Treat Sickle Cell Disease. *N Engl J Med* 2023; 389: 820-832; doi: 10.1056/NEJMoa2215643
58. D'Antiga L, Beuers U, Ronzitti G, Brunetti-Pierri N, Baumann U, Di Giorgio A, et al. Gene Therapy in Patients with the Crigler-Najjar Syndrome. *N Engl J Med* 2023; 389: 620-631; doi: 10.1056/NEJMoa2214084
59. Oregon: Prioritized List of Health Services Methodology - Developed by the Health Services Commission (HSC) *Updated 1/2/2018; Accessed September 2023*
60. House of Commons Health Committee. Standing Committee on Health-HESA. ourcommons.ca/Committees/en/HESA/About. Report Addressing Canada's Health Workforce Crisis March 2023 44th Parliament, 1st Session. Sean Casey, Chair. Accessed May 1, 2024
61. Laggssse J. Emergency medicine physicians top list of most burned-out specialties. August 31, 2023; <https://www.healthcarefinancenews.com/news/emergency-medicine-physicians-top-list-most-burned-out-specialties>. Accessed September 2023
62. Islam R, Kralj B, Sweetman A. Physician workforce planning in Canada: the importance of accounting for population aging and changing physician hours of work. *CMAJ* 2023; 195:E335-40; doi: 10.1503/cmaj.221239
63. Perera IM. What Doctors Want: A Comment on the Financial Preferences of Organized Medicine. *J Health Politics, Policy and Law* 2021; 46(4): 731-745; DOI: 10.1215/03616878-8970910
64. Who are baby boomers, Gen X, millennials, and Gen Z. *Macleans* January 8, 2020; macleans.ca/society/who-are-baby-boomers-gen-x-millennials-and-gen-z/. Accessed September 2023
65. Oldcorn C. Canada faces shortage of 100,000 nurses by 2030, healthcare will only 'get worse'. https://www.westernstandard.news/news/canada-faces-shortage-of-100-000-nurses-by-2030-healthcare-will-only-get-worse/article_d774f3b4-3063-11ee-8e21-5ba8cd73e5a9.html. Accessed August 2023
66. Government helping 6600 internationally educated healthcare professionals work in Canada. <https://www.canada.ca/en/employment-social-development/news/2024/internationally-educated-healthcare-professionals-work-in-canada.html>. January 15, 2024. Accessed May 1, 2024
67. Bonica A, Rosenthal H, Blackwood K, Rothman DJ. Ideological Sorting of Physicians in Both Geography and the Workplace. *J Health Politics, Policy and Law* 2020; 45(6): 1023-1057; DOI: 10.1215/03616878-8641555
68. Gosden T, Forland F, Kristiansen I, Sutton M, Leese B, Giuffrida A, et al. Capitation, salary, fee-for-service and mixed systems of payment: effects on the behaviour of primary care physicians (Review). *Cochrane Database of Systematic Reviews*. 2000; 3: CD002215; DOI: 10.1002/14651858.CD002215
69. Jia L, Scott A, Yuan B, Zhang L. Payment methods for healthcare providers working in outpatient healthcare settings (Review). *Cochrane Database of Systematic Reviews*. 2021; 1: CD011865; DOI: 10.1002/14651858.CD011865.pub2
70. Namburi N, Tadi P. *Managed Care Economics* NCBI Bookshelf; NIH; StatPearls, Treasure Is FL; StatPearls Publishing; January 2023; Last Updated January 30, 2023
71. Bayoumi I, Glazier RH, Jaakimainen L, Premji K, Kiren T, Frymire E, et al. Trends in attachment to a primary care provider in Ontario, 2008-2018: an interrupted time-series analysis. *CMAJ Open* 2023; doi: 10.9778/cmajo.20220167

72. Ogundeji Y, Clement F, Wellstead D, Farkas B, Manns B. Primary care physicians' of the role of alternative payment models in recruitment and retention in rural Alberta: a qualitative study. *CMAJ Open* 2021. DOI:109778/cmajo.20200202
73. Bayoumi I, Whitehead M, Li W, Kurdyak P, Glazier RH. Association of physician financial incentives with primary care enrolment of adults with serious mental illnesses in Ontario: a retrospective observational population-based study. *CMAJ Open* 2023; DOI:10.9778/cmajo.20210190
74. Yu Y, Lin F, Dong W, Li H, Zhang X, Chen C. The effectiveness of financial intervention strategies for reducing caesarean section rates: a systematic review. *BMC Primary Care* 2019; 19:1080; <https://doi.org/10.1186/s12889-019-7265-4>
75. Merali Z, Malhotra AK, Balas M, Lorello GR, Flexman A, Kiran T, et al. Gender-based differences in physician payments within the fee-for-service system in Ontario: a retrospective, cross-sectional study. *CMAJ* 2021; 193: E1584-91; DOI: 10.1503/cmaj.210437
76. Chaikof M, Cundiff GW, Mohtashami F, Millman A, Larouche M, Pierce M, Brennand EA, McDermott C. Surgical sexism in Canada: structural bias in reimbursement of surgical care for women. *Can J Surg* 2023; 66(4): E341-47; doi: 10.1503/cjs.022121.
77. AMA Equity Income Equity Update August 10, 2023; <https://www.albertadoctors.org/leaders-partners/income-equity/iei-update/income-equity--initiative-update-aug-10-2023>. Accessed April 2, 2024.
78. Perinatal Services British Columbia, Canada. <http://www.perinatalervicesbc.ca>. Accessed September 2023
79. Alberta Perinatal Health Program. <https://www.albertahealthservices.ca>. page 16988. Accessed September 2023
80. Rudoler D, Peterson S, Stock D, Taylor C, Wilton D, Blackie D, et al. Changes over time in patient visits and continuity of care among graduating cohorts of family physicians in 4 Canadian provinces. *CMAJ* 2022; 194: E1639-46; DOI: 10.1503/cmaj.220439
81. Kiran T. Keeping the front door open: ensuring access to primary care for all in Canada. *CMAJ* 2022; 194: E1655-6; DOI: 10.1503/cmaj.221563