

Supplemental Table 1. Summary of evidence and guidelines regarding radiograph use for common pediatric conditions

Condition	Practice guideline / Evidence	Recommendation
Bronchiolitis	Canadian Pediatric Society ¹	Bronchiolitis is a clinical diagnosis based on history and physical examination. Diagnostic studies, including chest radiograph, blood tests, and viral or bacterial cultures, are not recommended in typical cases.
	American Academy of Pediatrics ²	When clinicians diagnose bronchiolitis on the basis of history and physical examination, radiographic or laboratory studies should not be obtained routinely.
	National Institute for Health and Care Excellence ³	Do not routinely perform a chest X-ray in babies or children with bronchiolitis, because changes on X-ray may mimic pneumonia and should not be used to determine the need for antibiotics.
	Australasian Bronchiolitis Guidelines ⁴	Routine chest x ray is not recommended as it does not improve management in infants presenting with bronchiolitis and may lead to treatments of no benefit.
	Choosing Wisely – Pediatric Hospital Medicine ⁵	Do not order chest radiographs in children with asthma or bronchiolitis.
	Choosing Wisely Australia ⁶	Do not routinely undertake chest X-rays for the diagnosis of bronchiolitis in children or routinely prescribe salbutamol or systemic corticosteroids to treat bronchiolitis in children
	Friedman, BMJ 2021 ⁷	Avoid doing chest x-rays in infants with typical bronchiolitis
Asthma	Canadian Pediatric Society and Canadian Thoracic Society ⁸	Ancillary tests are not routinely recommended. Chest x-rays are rarely indicated for typical asthma exacerbations but may be useful to exclude complications (...) in patients with significant chest pain, hypoxemia, prolonged fever, or persisting asymmetry, or when a patient has failed to improve with maximal conventional treatment. In the absence of suggestive clinical features, chest x-rays increase the risk of overdiagnosis of pneumonia.
	National Heart Lung and Blood Institute ⁹	Chest radiography is not recommended for routine assessment but should be obtained for patients suspected of a complicating cardiopulmonary process, such as congestive heart failure, or another pulmonary process such as pneumothorax, pneumomediastinum, pneumonia, or lobar atelectasis.
	Global Initiative for Asthma ¹⁰	Radiographs are rarely indicated; however, if there is doubt about the diagnosis of asthma in a wheezing or coughing child, a plain chest x-ray may help to exclude

		structural abnormalities (e.g. congenital lobar emphysema, vascular ring), chronic infections such as tuberculosis, an inhaled foreign body, or other diagnoses.
	Choosing Wisely – Pediatric Hospital Medicine ⁵	Do not order chest radiographs in children with asthma or bronchiolitis.
	Choosing Wisely Australia ⁶	Do not routinely order chest X-rays for the diagnosis of asthma in children.
Abdominal pain	Choosing Wisely Australia ⁶	Do not routinely order abdominal X-rays for the diagnosis of non-specific abdominal pain in children
	Kellow, Radiology 2008 ¹¹	Abdominal radiography is often requested. However, its results contribute to patient treatment in a small percentage of cases. If a patient requires investigations beyond clinical history, physical examination and laboratory studies, the physician should be encouraged to request more definitive imaging.
Constipation	North American Society for Pediatric Gastroenterology, Hepatology and Nutrition ¹²	A thorough history and physical examination is generally sufficient to allow the practitioner to establish whether the child requires further evaluation (e.g. if fever, vomiting, bloody diarrhea, failure to thrive, anal stenosis, tight empty rectum) or has functional constipation.
	National Institute for Health and Care Excellence ¹³	Do not use a plain abdominal radiograph to make a diagnosis of idiopathic constipation. Consider a plain abdominal radiograph only if requested by specialist services in the ongoing management of intractable idiopathic constipation.
	Freedman 2014 ¹⁴	Misdiagnosis in children with constipation are more frequent in those in whom an abdominal x-ray was performed. The presence of stool on abdominal radiograph does not rule out an alternative diagnosis.
	Reuchlin-Vroklage 2005 ¹⁵	The limited amount of data shows conflicting evidence for an association between clinical symptoms of constipation and fecal loading on abdominal radiographs in children. The recommendation to perform a plain abdominal radiograph in case of doubt of the presence of constipation in a child cannot be supported.

References

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Supplemental Table 2. Data sources and associated study variables

Data source	Variables
Canadian Institute for Health Information – Discharge Abstract Database (CIHI-DAD)	Admission, ICU admission
National Acute Care Reporting System (NACRS)	ED discharge diagnosis, CTAS score, time and day of presentation
Ontario Health Insurance Plan (OHIP)	Radiograph use, surgical procedures
Registered Person Database (RPDB)	Patient sex, location of residence, date of birth, date of death
ICES Physician Database (IPDB)	Physician sex, years in practice, specialty, domestic vs foreign training
Ontario Institution Database (INST)	Number of patient visits, number of pediatric visits, hospital designation / academic status
Immigration, Refugees and Citizenship Canada's Permanent Resident Database	Immigration status
Office of the Registrar General Vital Statistics Database (ORGD)	Date of death
ASTHMA database	ED discharge diagnosis

ICU: Intensive care unit, CTAS: Canadian Triage Acuity Score, ED: Emergency Department

Supplemental Table 3. Imaging and diagnostic codes from the Ontario Health Insurance Plan (OHIP) and International Classification of Disease 9th and 10th versions (ICD9 and ICD10) used in the study

Imaging modality	OHIP diagnostic imaging codes	
Chest radiograph	X039, X040, X045, X047, X090, X091, X092, X096, X195, X209, X211	
Abdominal radiograph	X036, X037, X060, X100, X101, X103, X104, X108, X109, X110, X111, X113, X117, X122, X123, X129, X130, X134, X135, X137, X139, X140, X191, X197, X231, X232, X233	
Diagnosis	ICD-9 codes	ICD-10 codes
Bronchiolitis	4661, 46619	J210, J211, J218, J219
Asthma	493	J45
Abdominal pain	7890x	R100, R101, R103, R104, R193
Constipation	5640	K590

Supplemental Table 4. Pediatric low-value radiograph use by hospital-type, pediatric volume, and physician specialty at Ontario emergency departments between 2010-2019, excluding patients with chronic complex conditions¹

	Bronchiolitis OR (95% CI)	Asthma OR (95% CI)	Abdominal pain OR (95% CI)	Constipation OR (95% CI)
Number of observations	N = 57,467	N = 135,044	N = 318,841	N = 104,695
Hospital-type				
Pediatric academic (referent)	1	1	1	1
Adult academic	5.2 (4.7-5.7)	3.0 (2.8-3.2)	1.3 (1.2-1.3)	1.6 (1.5-1.7)
Community hospital with pediatrics	4.9 (4.7-5.2)	2.6 (2.5-3.7)	1.6 (1.6-1.7)	2.4 (2.3-2.4)
Community hospital without pediatrics	2.9 (2.8-3.1)	1.7 (1.6-1.7)	1.4 (1.3-1.4)	1.4 (1.3-1.4)
Pediatric volumes				
High (referent)	1	1	1	1
Medium	0.9 (0.8-0.9)	0.9 (0.9-0.9)	1.0 (0.9-1.0)	0.9 (0.8-0.9)
Low	0.7 (0.6-0.7)	0.6 (0.5-0.6)	0.5 (0.5-0.5)	0.4 (0.4-0.4)
Physician specialty				
Pediatric emergency medicine (referent)	1	1	1	1
Emergency medicine	3.3 (3.0-3.7)	2.8 (2.6-3.0)	1.2 (1.2-1.3)	1.7 (1.6-1.8)
Family medicine + emergency medicine	4.9 (4.6-5.2)	2.8 (2.6-2.9)	1.6 (1.6-1.7)	2.1 (2.0-2.2)
Pediatrics	1.7 (1.6-1.9)	1.7 (1.6-1.8)	1.0 (0.9-1.0)	1.0 (1.0-1.1)
Family medicine / general practice	3.5 (3.3-3.7)	2.2 (2.1-2.3)	1.3 (1.3-1.4)	1.5 (1.4-1.6)
Others ²	9.2 (8.1-10.5)	9.0 (8.1-10.0)	2.3 (2.2-2.5)	3.5 (3.3-3.9)

¹All models adjusted for patient age, sex, income quintile, immigrant/refugee status, complex chronic conditions, Canadian Triage Acuity Score, time of presentation, physician sex, physician years in practice, and physician training background (domestic vs international)

²Other physician specialties included critical care medicine, psychiatry, internal medicine, anesthesiology, orthopedic surgery, cardiology, nuclear medicine, otolaryngology, neonatal medicine, general surgery, and 44 others.

Supplemental Table 5. Pediatric low-value radiograph use by hospital-type, pediatric volume, and physician specialty at Ontario emergency departments between 2010-2019, excluding return visits within 72h¹

	Bronchiolitis OR (95% CI)	Asthma OR (95% CI)	Abdominal pain OR (95% CI)	Constipation OR (95% CI)
Number of observations	N = 57,467	N = 131,479	N = 295,966	N = 99,980
Hospital-type				
Pediatric academic (referent)	1	1	1	1
Adult academic	5.2 (4.7-5.8)	3.1 (2.9-3.3)	1.3 (1.2-1.4)	1.6 (1.5-1.8)
Community hospital with pediatrics	5.1 (4.8-5.3)	2.7 (2.6-2.8)	1.8 (1.7-1.8)	2.5 (2.4-2.5)
Community hospital without pediatrics	2.9 (2.8-3.1)	1.7 (1.6-1.7)	1.4 (1.4-1.5)	1.4 (1.3-1.4)
Pediatric volumes				
High (referent)	1	1	1	1
Medium	0.86 (0.81-0.91)	0.88 (0.85-0.91)	0.96 (0.94-0.99)	0.84 (0.81-0.87)
Low	0.65 (0.58-0.73)	0.56 (0.52-0.59)	0.48 (0.46-0.51)	0.38 (0.35-0.41)
Physician specialty				
Pediatric emergency medicine (referent)	1	1	1	1
Emergency medicine	3.4 (3.1-3.7)	2.9 (2.7-3.1)	1.3 (1.2-1.4)	1.8 (1.7-1.9)
Family medicine + emergency medicine	5.0 (4.6-5.3)	2.8 (2.7-3.0)	1.8 (1.7-1.8)	2.2 (2.1-2.3)
Pediatrics	1.8 (1.6-1.9)	1.7 (1.6-1.9)	1.0 (0.9-1.0)	1.1 (1.0-1.1)
Family medicine / general practice	3.6 (3.3-3.8)	2.2 (2.1-2.4)	1.4 (1.4-1.5)	1.5 (1.5-1.6)
Others ²	9.0 (7.9-10.3)	9.3 (8.4-10.2)	2.7 (2.5-2.8)	3.8 (3.5-4.2)

¹All models adjusted for patient age, sex, income quintile, immigrant/refugee status, complex chronic conditions, Canadian Triage Acuity Score, time of presentation, physician sex, physician years in practice, and physician training background (domestic vs international)

²Other physician specialties included critical care medicine, psychiatry, internal medicine, anesthesiology, orthopedic surgery, cardiology, nuclear medicine, otolaryngology, neonatal medicine, general surgery, and 44 others.

Supplemental Table 6. Pediatric low-value radiograph use by hospital-type, pediatric volume, and physician specialty at Ontario emergency departments between 2010-2019, excluding low pediatric volume hospitals¹

	Bronchiolitis OR (95% CI)	Asthma OR (95% CI)	Abdominal pain OR (95% CI)	Constipation OR (95% CI)
Number of observations	N = 57,098	N = 128,199	N = 306,873	N = 101,791
Hospital-type				
Pediatric academic (referent)	1	1	1	1
Adult academic	5.4 (4.8-5.9)	3.0 (2.8-3.2)	1.5 (1.4-1.6)	1.9 (1.7-2.0)
Community hospital with pediatrics	4.8 (4.6-5.1)	2.6 (2.5-2.7)	1.6 (1.6-1.7)	2.3 (2.3-2.4)
Community hospital without pediatrics	3.0 (2.9-3.2)	1.8 (1.7-1.9)	1.5 (1.4-1.5)	1.6 (1.5-1.6)
Pediatric volumes				
High (referent)	1	1	1	1
Medium	0.88 (0.84-0.93)	0.88 (0.85-0.91)	0.96 (0.94-0.99)	0.85 (0.82-0.88)
Physician specialty				
Pediatric emergency medicine (referent)	1	1	1	1
Emergency medicine	3.3 (3.0-3.7)	2.8 (2.6-3.0)	1.3 (1.3-1.4)	1.8 (1.7-2.0)
Family medicine + emergency medicine	5.0 (4.6-5.2)	2.7 (2.6-2.9)	1.6 (1.6-1.7)	2.2 (2.1-2.3)
Pediatrics	1.7 (1.6-1.9)	1.7 (1.6-1.8)	1.0 (0.9-1.0)	1.0 (1.0-1.1)
Family medicine / general practice	3.6 (3.4-3.9)	2.3 (2.2-2.5)	1.4 (1.3-1.5)	1.6 (1.6-1.7)
Others ²	9.1 (8.0-10.3)	9.0 (8.1-10.0)	2.4 (2.2-2.5)	3.6 (3.3-4.0)

¹All models adjusted for patient age, sex, income quintile, immigrant/refugee status, complex chronic conditions, Canadian Triage Acuity Score, time of presentation, physician sex, physician years in practice, and physician training background (domestic vs international)

²Other physician specialties included critical care medicine, psychiatry, internal medicine, anesthesiology, orthopedic surgery, cardiology, nuclear medicine, otolaryngology, neonatal medicine, general surgery, and 44 others.

Supplemental Figure 1. Trends in low-value radiograph use by indication at Ontario emergency departments from 2010-2019