Community EM

Use of diagnostic imaging in the emergency department for cervical spine injuries in Kingston, Ontario

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ABSTRACT

Objectives: This study assessed the use and clinical yield of diagnostic imaging (radiography, computed tomography, and medical resonance imaging) ordered to assist in the diagnosis of acute neck injuries presenting to emergency departments (EDs) in Kingston, Ontario, from 2002–2003 to 2009–2010.

Methods: Acute neck injury cases were identified using records from the Kingston sites of the Canadian National Ambulatory Care Reporting System. Use of radiography was analyzed over time and related to proportions of cases diagnosed with clinically significant cervical spine injuries.

Results: A total of 4,712 neck injury cases were identified. Proportions of cases referred for diagnostic imaging to the neck varied significantly over time, from 30.4% in 2002–2003 to 37.6% in 2009–2010 ($p_{trend} = 0.02$). The percentage of total cases that were positive for clinically significant cervical spine injury (''clinical yield'') also varied from a low of 5.8% in 2005–2006 to 9.2% in 2008–2009 ($p_{trend} = 0.04$), although the clinical yield of neck-imaged cases did not increase across the study years ($p_{trend} = 0.23$). Increased clinical yield was not observed in association with higher neck imaging rates whether that yield was expressed as a percentage of total cases positive for clinically significant injury ($p = 0.29$) or as a percentage of neck-imaged cases that were positive ($p = 0.77$).

Conclusions: We observed increases in the use of diagnostic images over time, reflecting a need to reinforce an existing clinical decision rule for cervical spine radiography. Temporal increases in the clinical yield for total cases may suggest a changing case mix or more judicious use of advanced types of diagnostic imaging.

RÉSUMÉ

Objectif: L'étude visait à évaluer l'utilisation et le rendement clinique de l'imagerie diagnostique (radiographie, tomodensitométrie, imagerie par résonance magnétique) dans la détermination des lésions aiguës du cou, aux services des urgences (SU), à Kingston, en Ontario, de 2002–2003 à 2009–2010.

Méthode: La recherche de cas de lésion aiguë du cou s'est faite à partir des dossiers archivés dans les hôpitaux de Kingston qui sont rattachés au Canadian National Ambulatory Care Reporting System. Le recours à la radiographie au fil du temps a été analysé, puis lié à des proportions de cas avérés de lésion, importante sur le plan clinique, de la colonne cervicale.

Résultats: Au total, 4,712 cas de lésion du cou ont été relevés. La proportion de cas dirigés vers l'imagerie diagnostique du cou a augmenté considérablement au cours de la période à l'étude; elle est passée de 30.4% en 2002–2003 à 37.6% en 2009–2010 ($p_{tendance} = 0.02$). Le pourcentage de cas totaux qui se sont révélés positifs à l'égard d'une lésion, importante sur le plan clinique, de la colonne cervicale («rendement clinique») a également connu une forte augmentation—celui-ci est passé de 5.8% en 2005–2006 à 9.2% en 2008–2009 ($p_{tendance} = 0.04$)—mais le rendement clinique des cas soumis à l'imagerie du cou n'a pas augmenté au cours de la période à l'étude ($p_{tendance} = 0.23$). Nous n'avons pas noté d'augmentation du rendement clinique en association avec l'augmentation des taux de recours à l'imagerie du cou, que ce rendement soit exprimé sous la forme de pourcentage de cas totaux, positifs à l'égard de lésions importantes sur le plan clinique ($p = 0.29$) ou sous la forme de pourcentage de cas positifs, avérés à l'imagerie du cou ($p = 0.77$).

Conclusions: Une augmentation du recours à l'imagerie diagnostique au fil du temps s'est dégagée de l'étude, ce qui reflète la nécessité de renforcer l'application d'une règle existante de décision clinique, relative à l'utilisation de la radiographie de la colonne cervicale. L'augmentation temporelle du rendement clinique en ce qui concerne le nombre total de cas peut laisser supposer un changement dans la

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composition des cas ou une utilisation plus judicieuse des types évolués d'imagerie diagnostique.

Keywords: emergency medicine, epidemiology, injury, medical record linkage, physician's practice patterns, radiography

The Canadian C-Spine Rule (CCR) is a clinical decision tool designed to allow physicians to safely and selectively order radiography and other images for alert, stable trauma patients at risk for cervical spine injury.[1] The CCR consists of three risk assessment questions and a range of motion test to determine if a patient requires diagnostic imaging. The rule is 100% sensitive and 42.5% specific for cervical spine injuries.[1,2] Implementation of the CCR in emergency departments (EDs) can result in significant decreases in imaging while capturing all clinically significant cervical spine injuries.[2]

Possible influences of the CCR on the clinical management of neck injuries have rarely been monitored in Canadian EDs since this clinical decision rule was implemented in 2001. These influences are important as the CCR may help optimize diagnostic imaging rates and save time and departmental resources.

Our emergency medical system in Kingston, Ontario, is a "natural laboratory" of sorts for the study of clinical diagnostic practices related to injury. Virtually all cases of injury requiring acute medical care in our community present to the two hospital-based EDs. We also have long-standing injury surveillance programs used in the study of acute injury prevention and treatment.[3] In the past, we have used this setting and these surveillance systems to study the ongoing use of radiography for acute ankle injuries.[4] Here we extended this opportunity to the examination of diagnostic imaging procedures for potential cervical spine injuries. The purpose of this study was to identify patterns in the use and clinical yield of diagnostic imaging between fiscal years 2002–2003 and 2009–2010 when the CCR was in place.

METHODS

Study design

We examined existing medical records for ambulatory cases that combined patient, diagnostic, and medical procedure information. Individual informed consent was not required for this study. Study procedures were approved by the Queen's University Health Sciences Research Ethics Board.

Data source

Cases of potential cervical spine injury were identified from Kingston General Hospital (KGH) and Hotel Dieu Hospital (HDH), which are both general teaching hospitals. We used comprehensive surveillance records that were compiled for the National Ambulatory Care Reporting System (NACRS) in Kingston.[5] The NACRS is an ED surveillance initiative that registers cases seeking ambulatory clinical care, day surgery, and ED care in some jurisdictions (e.g., mainly Ontario and Alberta, with contributions from other specific centres) within Canada.[6] The NACRS records provide information on patient demographics, diagnostic codes, and procedures ordered, including type(s) of diagnostic images and medical interventions.

Cases were obtained directly from the Decision Analysis Group located in KGH, which is our local site affiliate for the NACRS. Although a standardized data collection protocol is recommended nationally, local site variations in NACRS coding procedures are permitted.[6] Records are assembled retrospectively following the discharge of ambulatory patients from hospital. Coding is done by a small number of medical record nosologists following a formal review of ED, radiologic, procedural, and other medical records. Coders are required to adhere to a standard process with set coding rules. Coding of the most responsible diagnoses and all medical procedures is informed by the decisions of attending physicians. Coders can refine anatomic (generally fracture) diagnoses made by clinicians in the ED when presented with additional diagnostic information (e.g., between levels of cervical spine fractures). They cannot alter the final diagnostic category (e.g., a change from a fracture to a nonfracture diagnosis) even if supplemental evidence suggests that the physician diagnosis should be altered. The NACRS was re-engineered early in the study period (2002–2003) to accommodate the switch from the ninth to the tenth version of the *International Classification of Diseases*.[6] The accuracy of the final record depends on the quality of physician and administrative record keeping and the vigilance of coders to accurately reflect the nature and order of the clinical decisions.

Study protocol

Inclusions

Eligible neck injury cases (N = 4,712) in the NACRS database for Kingston for the fiscal years 2002–2003 through 2009–2010 were included. Cases were identified via review of all *International Classification of Diseases*, 10th revision (ICD-10), S-Codes (a maximum of 15 codes). Neck injury codes included ICD-10 codes S10 through 19.[7] Inclusions were as follows: S10, superficial injury of neck; S11, open wound of neck; S12, fracture of neck; S13, dislocation, sprain, and strain of joints and ligaments at neck level; S14, injury of nerves and spinal cord at neck level; S15, injury of blood vessels at neck level; S16, injury of muscle and tendon at neck level; S17, crushing injury of neck; and S19, other and unspecified injuries of neck. Analyses were based on the most responsible diagnosis for neck injuries.

Radiographic procedures

Procedure codes were used to describe the use of radiography ordered by attending clinicians. Up to nine imaging procedures could be coded, and those indicating neck imaging were as follows: 3EQ10VA, x-ray to head and neck without contrast; 3EQ10VN, x-ray to head and neck fluoroscopy; 3FY20VA, computed tomography (CT) neck without contrast; 3FY20VC, CT neck after intravenous injection contrast; 3FY20WC, CT soft tissue neck with enhancement; 3SC10VA, x-ray specific vertebrae without contrast; 3SC20WA, CT specific vertebrae without enhancement; 3SC20WC, CT specific vertebrae with enhancement; 3SC40WA, magnetic resonance imaging (MRI) specific vertebrae without enhancement; and 3SC40WC, MRI specific vertebrae with enhancement.

Clinically significant cervical spine injuries

As per CCR criteria, cases of clinically significant cervical spine injury had confirmed diagnoses of any of 1) S12, fractures of neck; 2) S13.1, dislocation of cervical vertebrae; or 3) S14.19, unspecified lesion of cervical spinal cord.[1,2] An FRCPC-trained physician (R.J.B.) who was part of the investigative team that developed the CCR reviewed the electronic medical records, including images for each case that were coded with the three diagnoses. The review confirmed that the original physician diagnoses were consistent with a "clinically significant" cervical spine injury, as per CCR criteria,[1,2] and that anatomic codes recorded by medical record technicians were accurate. Of the 430 cases that were originally coded as clinically significant injuries by attending physicians, 270 (62.8%) cases were clinically significant fractures classified correctly by anatomic location, 64 (14.9%) were clinically significant fractures that were misclassified only by anatomic location, 5 (1.2%) were dislocations of cervical spine vertebrae, 6 (1.4%) were lesions to the cervical spine spinal cord, and 85 were not "clinically significant" injuries by CCR criteria (Figure 1).

Data analysis

Counts of neck injury cases presenting to EDs were described by study year. Procedures used in the diagnosis of these cases were summarized by imaging codes. Clinical diagnoses for these neck injury cases were described using the ICD-10 S-Codes for the most responsible diagnoses.

Proportions of cases that were referred for any type of diagnostic imaging and then any imaging specific to the neck were estimated by study year, and 95% confidence intervals (CIs) were calculated using the normal approximation to the binomial. Percentages of

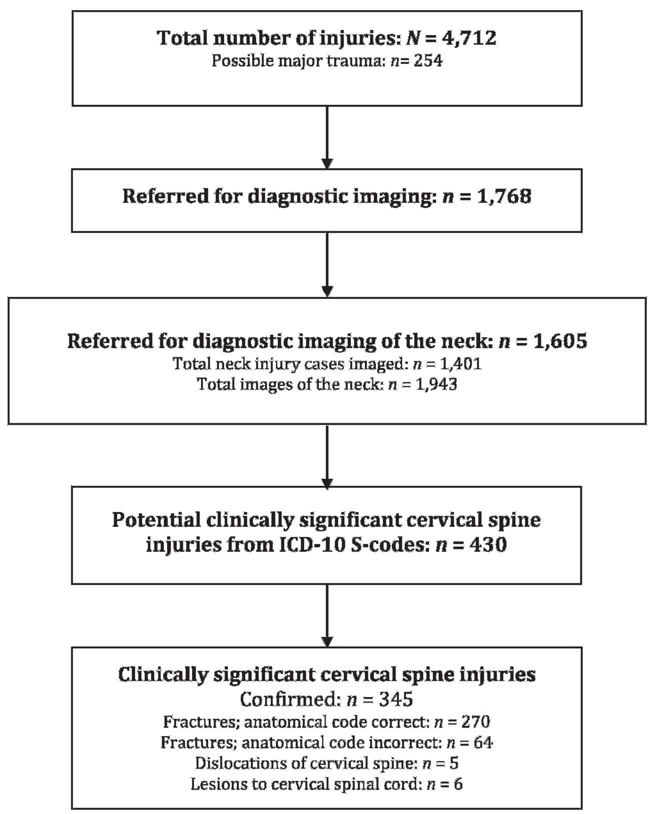

Figure 1. Participant flow diagram.

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both the total neck injury cases and the imaged neck injury cases that were positive for clinically significant cervical spine injury were then estimated along with associated 95% CIs. We refer to these percentages as measures of "clinical yield."

Chi-square tests for differences and trends in proportions and Poisson regression analyses were used to determine whether variations in the observed diagnostic or procedure codes were significant over time and whether the clinical yields of imaging procedures improved with increased use of diagnostic images. An important potential bias in this study was the inclusion of ineligible cases. The latter included cases at two extremes: 1) those diagnosed as superficial injuries with an improbable injury mechanism for cervical spine injury (S10, superficial injury of neck) and 2) cases with potential multiple trauma, operationally defined as those with images to multiple organ systems (e.g., cervical spine plus abdomen or thorax). To assess the potential for such bias, we examined proportions of these two types of cases over time, as well as the proportion of the potential multiple traumas with final diagnoses of clinically significant cervical spine injury.

RESULTS

Most responsible diagnoses

The total number of neck injury cases available for study was 4,712 and averaged 589 cases (range 514–678) per fiscal year. Clinical diagnoses made for these 4,712 cases are shown in Table 1. The most common diagnostic code was S13 (dislocation, sprain, and strain of joints and ligaments at neck level). Of the 1,623 S13 cases, 1,209 (74.5%) were sprains and strains and 226 (13.9%) were whiplash-associated disorders. A total of 345 clinically significant cervical spine injuries were reported (see Figure 1) and included 334 (96.8%) fractures of which 270 (78%) had an accurate anatomic location. Of the latter, 31 were to C1, 71 were to C2, 17 were to C3–4, 118 were to C5–7, 32 were multiple cervical fractures, and 1 was an unspecified neck fracture. In addition, there were 5 dislocations of the cervical vertebrae, 6 unspecified lesions of the cervical spine cord, and 64 fracture cases with a misclassified anatomic location. There were 74 cases originally coded as fractures with no evidence of a clinically significant fracture on review. Annual counts of these ranged from 3 in 2002–2003 to 23 in 2009–2010, suggestive of an increase over time ($p < 0.001$). The annual number of clinically significant cervical spine injuries varied between 34 and 51 per year. Use of the code S19, other and unspecified injuries of the neck, declined quite markedly over the 8-year study period.

Radiographic procedures

Table 2 shows that 1,768 cases (37.5%) were referred for some type of diagnostic imaging and 1,401 cases (29.7%) had a primary procedure code indicative of an image of the neck. These were most commonly radiographs of cervical spine vertebrae without contrast, followed by CT scans of cervical spine vertebrae without enhancement. The same patterns were observed when neck images of the nine potential image procedural codes (n = 1,943) were considered.

Between 2002–2003 and 2009–2010, annual proportions of acute neck injury cases referred for radiography varied significantly. Proportions of cases for which any imaging was ordered ($p_{\text{trend}} = 0.05$) and specifically images to the neck were ordered ($p_{\text{trend}} = 0.02$) increased over the study period. There were no clear linear patterns in these proportions (Table 3). Although the proportions of total cases that were positive for clinically significant cervical spine injury increased over time ($p_{\text{trend}} = 0.04$), temporal increases were not observed in terms of the proportions of neck-imaged cases positive for such injuries ($p_{\text{trend}} = 0.23$).

Potentially ineligible cases

Cases diagnosed as superficial injuries to the neck varied from 23 to 119 per year and increased over time ($p < 0.05$). For potential cases of multiple trauma, in the 4,712 records, 254 (5.4%; range 25–40 cases/year) included codes indicating the imaging of multiple organ systems, and 100 of 4,712 (2.1%) had a diagnosis of a clinically significant cervical spine injury (range 10–16 cases/year) as the most responsible diagnosis. The latter cases represented 1.5 to 2.8% of the total cases per year and were consistent across the 8 years of the study.

Clinical yield of radiographic procedures

An increased clinical yield was not observed in association with higher neck imaging rates whether that yield

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Table 1. Clinical diagnoses of neck injuries presenting to emergency departments in Kingston, Ontario, 2002–2003 to 2009–2010 (N = 4,712)

ICD-10 code	ICD-10 description	Fiscal year 2002–2003	2003–2004	2004–2005	2005–2006	2006–2007	2007–2008	2008–2009	2009–2010	Total
Clinically significant neck injuries by CCR criteria										
S12	Fracture of neck	44	37	44	34	44	37	49	45	334
S13.1	Dislocation of cervical vertebrae	0	2	1	0	0	1	0	1	5
S14.19	Lesion of cervical spine	0	0	1	0	0	1	2	2	6
	Subtotal	44	37	46	34	44	39	51	48	345
All neck injuries										
S10	Superficial injury of neck	27	79	60	23	107	81	119	110	606
S11	Open wound of neck	16	24	17	25	10	17	17	19	145
S12	Fracture of neck	47	45	50	44	50	44	60	68	408
S13	Dislocation, sprain, and strain of joints and ligaments at neck level	231	227	203	176	196	182	183	225	1,623
S14	Injury of nerves and spinal cord at neck levels	4	5	5	4	6	7	10	13	54
S15	Injury of blood vessels at neck level	2	0	3	2	0	2	1	0	10
S16	Injury of muscle and tendon at neck level	18	8	4	19	23	22	25	24	143
S17	Crushing injury of neck	2	0	1	1	1	0	0	0	5
S19	Other and unspecified injuries of neck	331	228	267	295	174	158	139	123	1,715
	Total	678	616	611	589	567	514	555	582	4,712

CCR = Canadian C-Spine Rule; ICD-10 = International Classification of Diseases, 10th revision.[7]

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Table 2. Diagnostic imaging of neck injuries presenting to emergency departments in Kingston, Ontario, 2002–2003 to 2009–2010 (*N* = 4,712)

		n (%)
Total number of injuries		4,712 (100.0)
Total people sent for imaging (any type)		1,768 (37.5)
Primary image codes		
Total cases imaged for neck injury		1,401 (100.0)
3EQ10VA	X-rays to head/neck without contrast	38 (2.7)
3EQ10VN	X-rays to head/neck fluoroscopy	3 (0.2)
3FY20VA	Computed tomography to neck without contrast	12 (0.9)
DFY2OVC	Computed tomography to neck after IV injection contrast	0 (0.0)
3FY2OWC	Computed tomography to neck with enhancement	0 (0.0)
3SC10VA	X-rays to specific vertebrae without contrast	1,087 (77.6)
3SC2OWA	Computed tomography to specific vertebrae without enhancement	246 (17.6)
3SC20WC	Computed tomography to specific vertebrae with enhancement	1 (0.1)
3SC4OWA	Magnetic resonance imaging to specific vertebrae without enhancement	13 (0.9)
3SC40WC	Magnetic resonance imaging to specific vertebrae with enhancement	1 (0.1)
Any of 9 image codes		
Total cases imaged for neck injury		1,943 (100.0)
3EQ10VA	X-rays to head/neck without contrast	46 (2.4)
3EQ10VN	X-rays to head/neck fluoroscopy	3 (0.2)
3FY20VA	Computed tomography to neck without contrast	13 (0.7)
DFY2OVC	Computed tomography to neck after IV injection contrast	5 (0.3)
3FY2OWC	Computed tomography to neck with enhancement	3 (0.2)
3SC10VA	X-rays to specific vertebrae without contrast	1,432 (73.7)
3SC2OWA	Computed tomography to specific vertebrae without enhancement	415 (21.4)
3SC20WC	Computed tomography to specific vertebrae with enhancement	5 (0.2)
3SC4OWA	Magnetic resonance imaging to specific vertebrae without enhancement	20 (1.0)
3SC40WC	Magnetic resonance imaging to specific vertebrae with enhancement	1 (0.1)

IV = intravenous.

was expressed as a percentage of total cases positive for clinically significant injury ($p = 0.29$) or as a percentage of neck-imaged cases positive for such injuries ($p = 0.77$). The proportion of imaged cases where CT was used was 34 of 223 (15.2%) in 2002–2003. This increased in a monotonic fashion to a high of 79 of 236 (33.5%) in 2009–2010. Similarly, proportions of imaged cases referred for MRI increased from 0 of 223 (0%) in 2002–2003 to 8 of 236 (3.4%) in 2009–2010.

DISCUSSION

The most important finding from this study was that use of imaging for the diagnosis of acute neck injuries varied over the 8-year study period, with the highest proportions of cases imaged in the final years of this study. Use of any diagnostic imaging of the neck was 40.5% in 2009–2010. Although this represents an absolute increase of 7.6% from 2002–2003, when the study began, it remains below the predicted radiography rate of 58.2% when the CCR is fully implemented in large EDs.[1]

A second important finding was that the percentage of total cases that were positive for clinically significant injury (our estimate of clinical yield) also varied by study year, from a minimum of 5.8% in 2005–2006 to a high of 9.2% in 2008–2009. Slight decreases were observed in the clinical yield of radiographic procedures for imaged cases that were positive for clinically significant cervical spine injury.

Overall, our findings suggest that there may be a tendency for emergency physicians in our setting to order more diagnostic imaging for acute neck injuries during recent years. This is almost certainly attributable in part to the ordering of CT scans (and to a much lesser extent MRIs) as they have become more accessible. The findings provide somewhat mixed evidence surrounding the clinical yield of these images. Physicians may have been more judicious in their ordering of imaging because the total yield has

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Table 3. Frequency of injuries presenting to emergency departments in Kingston, Ontario, requiring any diagnostic imaging and imaging specific to the neck, by year from 2002–2003 to 2009–2010

		Any images			Any images of the neck			Clinically significant cervical spine injury				
Year	Total cases	*n*	%	95% CI	*n*	%	95% CI	*n*	% total cases	95% CI	% imaged cases	95% CI
2002–2003	678	223	32.9	29.4–36.4	206	30.4	26.9–33.8	44	6.5	0.0–14.5	21.4	7.6–35.2
2003–2004	616	219	35.6	31.8–39.3	192	31.2	27.5–34.8	39	6.3	0.0–13.9	20.3	7.0–33.7
2004–2005	611	239	39.1	35.2–43.0	222	36.3	32.5–40.1	46	7.5	0.0–15.4	20.7	8.2–33.3
2005–2006	589	217	36.8	32.9–40.7	201	34.1	30.3–38.0	34	5.8	0.0–12.9	16.9	5.0–28.8
2006–2007	567	213	37.6	33.6–41.6	195	34.4	30.5–38.3	44	7.8	0.0–15.9	22.6	9.3–35.8
2007–2008	514	216	42.0	37.8–46.3	186	36.2	32.0–40.3	39	7.6	0.0–15.2	21.0	8.4–33.5
2008–2009	555	205	36.9	32.9–41.0	184	33.2	29.2–37.1	51	9.2	0.3–18.0	27.7	13.3–42.1
2009–2010	582	236	40.5	36.6–44.5	219	37.6	33.7–41.6	48	8.2	0.2–16.3	21.9	9.3–34.5
Total	4,712	1,768	37.5	36.1–38.9	1,605	34.1	32.7–35.4	345	7.3	0.0–15.5	21.5	8.0–35.0

increased over time. At the same time, there was also increased identification of clinically nonsignificant fractures by CCR criteria. The case mix of these neck-injured patients may have become more serious in later years due to the tendency for patients to seek ambulatory care elsewhere for minor injuries due to high ED volumes, although evidence was mixed in support of that argument. Although the clinical yield of imaging overall for these cases remained stable over time, advanced imaging likely contributed to a refinement of the anatomic injury diagnosis.

The CCRs were implemented in 2001 to reduce the burden of imaging procedures in the provision of emergency medical care.[1] Ordering of cervical spine images is common and can significantly contribute to rising health care costs.[8] When consistently implemented, the CCR reduced cervical spine imaging by 12.8% in the intervention arm of a multisite cluster randomized trial, whereas the rate of imaging increased by 12.5% in the control arm of this trial.[1] Such efficiencies clearly could lead to reduced costs, resource use, and wait times in EDs.

KGH, one of two hospital-based EDs in our research setting, was one of six control sites in the above multisite randomized controlled trial. At that time, formal protocols were not implemented for the use of the CCR in Kingston. It was expected that the emergency physicians associated with our two teaching hospitals would be well-versed in the principles and application of the CCR as they were involved in its creation and have been similarly involved in the development of clinical decision rules for the use of radiography in the diagnosis of ankle fractures[9] and minor head injury.[10] We expected that the implementation of the CCR should lead to lower rates of imaging for acute neck injury cases because physicians would apply this rule as intended. The results were not consistent with such reductions. This negative finding was similar to an analogous Kingston study that focused on ankle injuries.[4] Although the increases could be attributable to other explanations, on balance, such findings still point to a need for ongoing educational initiatives surrounding application of the CCR and other like radiography rules. These types of strategies can and do lead to substantial reductions in the use of radiography,[11–15] as can the presence of local advocates for use of clinical decision rules[16] and the incorporation of

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automatic prompts to apply the rules from the electronic patient management system.[4]

Our finding of a temporal increase in the clinical yield of images that were positive for clinically significant cervical spine injury was important. Again, this may be associated with more selective and appropriate use of radiographic imaging or the tendency for presenting injuries to be more serious in later years of study. We also observed a concurrent increase in the use of CT and MRI methods, which in turn may lead to more sensitive identification of smaller but clinically insignificant fractures. One interpretation is that the increased clinical yield represents an improvement in patient management, consistent with better "rule out" practices for clinically significant injury (e.g., exclusion of superficial injuries) prior to the decision to request imaging procedures, pointing to some potential success in the implementation of the CCR.

Temporal declines in the use of the "other and unspecified injuries to the neck" diagnostic code (S19) were also notable. The availability of CT and MRI may also have contributed to more refined diagnoses in the later years of study. It is also likely due to an increasing familiarity with ICD-10 by coders.

The strengths of our study include its large size and the comprehensive nature of the available NACRS coding for both diagnostic codes and imaging procedure codes. All diagnoses were based on physician decisions informed by available imaging findings, and we performed a second clinical review to ensure consistency of diagnoses with CCR definitions of clinically significant cervical spine injuries. The study also involved patients from general as opposed to highly specialized study populations. Hence, the findings can be generalized cautiously to similar EDs in tertiary general hospital settings.

An important limitation of our study is that we did not have access to individual physician ordering patterns with respect to application of the CCR for these acute neck injury cases. It is possible that use of the rules varied widely between individual physicians, only some of whom did not follow them and hence account for any observed increases in use. Second, reliance on a retrospective review of NACRS records is clearly not optimal for studies such as ours. Medical records do not necessarily contain a complete accounting of all information used in the making of clinical decisions, and our analysis provides novel but only indirect evidence surrounding application of the CCR. Third, compliance with clinical decision rules may additionally be affected by high patient volumes, especially during recent study years, where ED crowding has become an important clinical challenge in Kingston and elsewhere.[17] Fourth, the accuracy of the NACRS codes in Kingston depends on attending clinicians and their recorded diagnoses and perceived order of importance. It is also beholden to the coders and their vigilance in documenting the intentions of clinicians; some inaccuracies in the nature and order of codes are inevitable. This may have especially applied to the early years of surveillance and the consequent switch from the ICD-9 to the ICD-10, as evident in the observed reduction in unspecified codes as time went on. Finally, based on available administrative and clinical data, it was not possible to systematically exclude from our case series all very minor injuries or the small number of patients who were not alert or who presented with unstable trauma to the neck or were multiple trauma cases. These patients would be ineligible for assessment via the CCR as it was not intended to be applied to such clinical situations.[1,2] Inclusion of the latter cases likely inflated both our estimates of imaging rates and clinical yield, although this bias is likely to be modest and consistent across the study years.

CONCLUSION

This study assessed the use and clinical yield of imaging procedures ordered to assist in the diagnosis of acute neck injuries presenting to EDs in Kingston, Ontario, from 2002–2003 to 2009–2010. Contrary to expectations, we did not observe decreases in the use of diagnostic imaging over time. This was inconsistent with the assumed application of the CCR to acute neck injury cases for our general ED practice, although attending physicians generally view clinical decision rules as being a helpful adjunct for medical care.[18] On a more positive note, observed increases in clinical yield among the total patient population suggest more judicious use of better methods of diagnostic imaging for potential cervical spine injuries. Given these findings, periodic initiatives to reinforce the content of the CCR to emergency physicians and the entire ED management system might be required.

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