CHAPTER 3

Effect of the implementation of a new guideline for minor head injury on computed tomography-ratio and hospitalizations in the Netherlands

Eur J Emerg Med. 2020;27(6):441-446

Crispijn L. van den Brand*
Joeri R. Perotti*
M. Christien van der Linden
Tanya Tolido
Korné Jellema

* Both authors contributed equally

ABSTRACT

Objective

A new nationwide guideline for minor head injury was introduced in the Netherlands in 2010. The effect on CT ratio and hospital admission ratio after introduction of the guideline is unknown. The aim was to reduce these numbers as part of cost-effective health care. Therefore, we assessed the effect on these variables after introduction of the guideline.

Methods

We used an interrupted time series study design. Data selection was done three years before (2007-2009) and several years after (2012, 2014, 2015) introduction of the guideline.

Results

Data collection was performed for 3880 patients. Introduction of the new guideline was associated with an increase in CT ratio from 24.6% before to 55% after introduction ($P < 0.001$). This increase is the result of both the new guideline and a secular trend. Besides this, hospital admissions increased from 14.7% to 23.4% ($P < 0.001$) during the study period. This increase was less clearly associated with the new guideline. After introduction of the guideline there was no significant difference in (intra)cranial traumatic findings (2.6% vs. 3.4%; $P = 0.13$) and neurosurgical interventions (0.1% vs. 0.2%; $P = 0.50$).

Conclusions

Between 2007 and 2015, a marked increase in CT ratio and hospital admissions has been observed. The increase in CT ratio seems to be caused both by the new guideline and by a secular trend to perform more CT scans. Adaptations to the guideline should be considered to improve patient care and cost-effectiveness in patients with minor head injury.

Introduction

Minor head injury (MHI) is an everyday problem in emergency departments (EDs). Exact numbers for the Netherlands are lacking, but a distinct increase in ED visits for traumatic brain injury (TBI) has been observed over the past decades.[1] Traumatic intracranial findings occur in 7-10 % of MHI patients and less than 1% will require neurosurgical intervention.[2-4] Computed Tomography (CT) of the head is the most used imaging modality, because it is a fast and reliable method for detecting traumatic findings.[5]

Obtaining a CT-scan for every head trauma is undesirable, because of various reasons such as cost-effectiveness, overdiagnosis, ED crowding and radiation exposure.[6,7] There are various guidelines to determine for which patients a CT-scan is indicated. Many guidelines are derived from the Canadian CT Head Rule (CCHR) and the New Orleans Criteria (NOC).[8,9] These decision rules are externally validated and have a high sensitivity for both clinically important brain injury and neurosurgical intervention.[10-13] Nevertheless, the applicability of these decision rules is limited to patients who experienced loss of consciousness (LOC), post-traumatic amnesia (PTA) or confusion.[8,9] However, intracranial complications occur both in patients with and without LOC and PTA.[14] Therefore, a major disadvantage of these guidelines is the lack of recommendations in case of the absence of LOC and/or PTA.

A decision rule that is applicable to all MHI patients, was established later on by a Dutch research group: the CHIP prediction rule.[3] A recent validation study showed a performance comparable to the CCHR and NOC.[2] The CHIP prediction rule, with some adjustments, led to the development of the current Dutch guideline for MHI in 2010.[15] Although the sensitivity of the guideline is expected to be very high, implications for clinical practice, like the total number of CT-scans performed, are uncertain. The purpose of this study is to determine the impact of the introduction of a new guideline for MHI. We compared CT ratio before and after introduction of the new guideline, and simultaneously the effect on hospital admission rates.

Methods

Study setting and patients

We used an interrupted time series (ITS) study design. All data were collected from a Dutch non-academic hospital with two separate ED locations. One location concerns a level-1 trauma centre with an annual number of visitors to the ED of 46,500 (2007) – 52,000 (2015); level-1 meaning that all possible traumas can be treated there. The other location is a level-3 trauma centre with an annual number of ED-visitors of 20,000 (2007) – 17,500 (2015). The declining number of visitors to this last ED is due to reallocation of patients to other EDs.

The study periods involved the first three months of six different years: 2007; 2008; 2009; 2012; 2014 and 2015. The 'after period' was intentionally chosen some years after 2010, to guarantee that all hospitals were familiar with the new Dutch guidelines. There is no specific reason for the lack of data concerning the year 2013, other than the data collection being performed in two different time frames.

All patient records concerning MHI were selected manually from the electronic patient records. Data extraction from these records was performed by physicians under supervision of the corresponding author (CvdB). In case no abnormalities or symptoms were specified, these were assumed to be absent. In case of discrepancies or doubt about the information in the patient record the record was reviewed by CvdB.

Patients were included when they met the criteria for MHI as described later in this section. Other inclusion criteria were presentation to the ED within 24 hours of injury, and age of at least 16 years. Exclusion criteria were 'reassessed patients' and 'transferred patients'.

All CT-scans were performed according to standard trauma protocol. Assessment of the CT-scans was carried out by a (neuro)radiologist, and by the treating neurologist. In case of disagreement, a second (neuro)radiologist and neurologist reached consensus.

Data collection

We collected the following data from the electronic patient record: demographic data, Glasgow Coma Scale (GCS) on entry, whether a CT-scan of the head was made, CT findings, hospital admissions and neurosurgical interventions. A neurosurgical intervention is defined as any neurocranial operation for the sustained head trauma carried out by a neurosurgeon within 30 days after the trauma, including the placement of an intracranial pressure monitoring device. We concurrently verified the presence of major and minor CT-criteria for each patient, according to the 2010 guideline, so that guideline adherence could be measured [15].

The 2010 Dutch MHI guideline

The Dutch guideline for MHI was introduced nationwide in 2010 and was based on the CHIP decision rule [3,15]. It is applicable to all patients with MHI. MHI was defined as: *Head injury is any trauma to the head, other than superficial injuries to the face.*

For minor head injury the following criteria apply:

- *GCS at first examination 13-15*
- *In case of loss of consciousness: no more than 30 minutes*
- *In case of posttraumatic amnesia: no more than 24 hours*

The guideline has major and minor criteria for a head CT. In case of 1 major or 2 minor criteria a CT-scan of the head is indicated.

Major criteria: GCS < 15 on presentation; signs of skull fracture; vomiting; posttraumatic amnesia ≥ 4h; GCS deterioration ≥ 2 points (1 hour after presentation); pedestrian or cyclist versus vehicle; ejected from vehicle; coumarin use, focal neurologic deficit[1]; posttraumatic seizure; suspicion of intracranial injury after focal “high impact” injury[2].

Minor criteria: fall from any elevation; posttraumatic amnesia 2-4 hours; visible injury to the head, (excluding the face); loss of consciousness; GCS deterioration of 1 point (1 hour post presentation); age ≥ 40[3].

Indications for admission according to the guideline are: new clinically significant findings on CT-scan; GCS < 15; focal neurologic deficit; indication for CT-scan, but CT-scan not (yet) performed; alarming signs for the clinician such as intoxication with alcohol and/or drugs; other injuries that require admission[4].

Outcome measures

The primary outcome measure is the change in level and trend in the percentage of head CT-scans for MHI performed: the crude CT ratio and the standardized CT ratio.

1 Focal neurologic deficit was a minor criterium in the original CHIP rule.
2 Suspicion of intracranial injury after focal “high impact” injury was no criterium in the original CHIP rule.
3 Age 40-60 was a minor criterium and age ≥60 was a major criterium in the original CHIP rule.
4 The CHIP rule does not formulate indications for admission.

The crude CT ratio is the percentage of patients with head CT. The standardized CT ratio is the quotient of the number of cases with a head CT and the number of cases with an indication for head CT according to the 2010 guideline.[15]

Secondary outcome measures are the changes in level and trend in the percentage of patients admitted to the hospital and in the number of neurosurgical interventions within 30 days after the trauma. Another secondary outcome measure is guideline adherence. The study was approved by the regional medical research ethics committee and informed consent was waived (IRB Southwest Holland, nr. 13-054).

Statistical analysis

Data were analyzed using descriptive statistics, c^2 tests and Mann-Whitney U tests where appropriate. The impact of the new guideline on CT ratio and admission percentage was analyzed with an interrupted time series approach, hereby controlling for the observed level and trend in the data before the intervention.[16] The following regression model was used:

$U_t = b_0 + b_1T + b_2C_t + b_3TC_t$ where b_0 represents the baseline level before implementation of the new guideline, b_1 represents the change in outcome associated with a time unit increase (representing the underlying trend, slope), b_2 is interpreted as the level change following the intervention and b_3 represents the slope change following the intervention. The time unit used in the model is months.

Significance threshold was set at $P < 0.05$. The statistical package for the social sciences (IBM Corp., IBM SPSS Statistics for Windows, version 22.0. Armonk, New York USA) was used for analyses.

Results

During the study periods a total of 3880 eligible patients were seen at one of the two EDs and were included in our study. Of those patients, 1823 (47.0%) visited the hospital before- and 2057 (53.0%) did so after introduction of the guideline. Patient characteristics are shown in Table 1. Notably, the median age and specifically the proportion of patients over 40 years of age was higher in the group of patients seen after the introduction of de guideline.

Table 1. Basic demographic characteristics and hospital location

	2007-2009 (before group) (n=1823)	2012-2014-2015 (after group) (n=2057)	*P*-value[1]
Demographics			
• Median age y (IQR)	40 (25-60)	46 (28-67)	< 0.001
• Age ≥40y n (%)	917 (50.3)	1211 (58.9)	< 0.001
• Male gender n (%)	1116 (61.2)	1215 (59.1)	0.172
Hospital location			
• Trauma centre	1293 (70.9)	1611 (78.3)	< 0.001

[1]Difference between before-group (2007-2009) and after-group (2012, 2014, 2015).

Traumatic (intra)cranial CT findings were present in 2.6% of patients in the 'before' group and 3.4% of patients in the 'after' group. However, this difference was not significant, as shown in Table 2. Four patients with at the first visit missed (intra) cranial traumatic findings (or possible intracranial findings) were identified, two before introduction of the guideline and two after introduction of the guideline (Supplementary Table 1). Facial fractures were found on CT in merely 0.9% of the 'before' group, and in 4.0% of the 'after' group, this difference was statistically significant. In line with these findings, there was no noteworthy increase in the number of neurosurgical interventions between the 'before' and 'after' group, which was 0.1% in the before group and 0.2% in the after group (Table 2).

Before introduction of the guideline the crude CT ratio was on average 24.6%. After introduction of the guideline, the crude CT ratio increased to 55%. A sensitivity analysis of the period 2012-2015, including only those patients in which the guideline was adhered, showed a similar crude CT ratio of 55.8%. The ITS analysis showed a (non-significant) positive time trend (slope) in crude CT ratio, a significant increase in level after introduction of the new guideline and a slight (non-significant) change of slope following the introduction of the guideline (Table 3). The standardized CT ratio[5] increased each year and was on average 51.9% before introduction of the guideline and 100.5% after introduction of the guideline (Table 2, Supplementary Table 2). The ITS analysis for standardized CT ratio showed similar results as for the crude CT ratio; a (non-significant) positive time trend (slope) (b_1 = 0.48, p = 0.08), a significant increase in level after introduction of the new guideline (b_2 = 31.85, p = 0.05) and a slight (non-significant) change of slope following the introduction of the guideline (b_3 = -0.21, p = 0.50) (Table 3, Figure 1). Hospital admissions have increased from 14.7% before- to 23.4% after introduction of the guideline. However, there was no significant deviation from the secular trend after introduction of the guideline (Table 2, Table 3).

Table 2. (Standardized) CT ratio, traumatic CT findings, hospital admission and neurosurgical intervention

	2007-2009 (n=1823)	2012-2014-2015 (n=2057)	*P* value[1]
Head CT-scans n (%)	448 (24.6)	1131 (55)	< 0.001
Standardized CT ratio	51.9	100.5	< 0.001
(Intra) cranial traumatic CT findings n (%)	47 (2.6)	70 (3.4)	0.13
• Hemorrhagic intracranial traumatic findings[2]	24 (1.3)	38 (1.8)	
• Isolated skull fracture[3]	9 (0.5)	9 (0.4)	< 0.001
• Intracranial traumatic findings plus fracture	14 (0.8)	23(1.1)	
Isolated facial fracture(s) on CT n (%)	16 (0.9)	83 (4.0)	
Hospital admission n (%)	268 (14.7)	481 (23.4)	< 0.001
Neurosurgical intervention n (%)	2 (0.1)	4 (0.2)	0.50

[1] Difference between before-group (2007-2009) and after-group (2012, 2014, 2015).
[2] hemorrhagic intracranial traumatic findings means all traumatic intracranial findings: subdural hematoma, epidural hematoma, traumatic subarachnoid hemorrhage and parenchymal contusion.
[3] Isolated skull fractures means all fractures to the neurocranium.

Guideline adherence, since the introduction of the guideline, was good; when a CT was indicated according to the guideline, a CT-scan was performed in 85.7% of the patients. In addition, a CT-scan was performed in merely 17.9% of the patients when the guideline dictated not to perform a CT-scan (Supplementary Table 3). That equalizes 84.1% overall guideline adherence.

5 The standardized CT ratio is the quotient of the number of cases with a head CT and the number of cases with an indication for head CT according to the 2010 guidelines.

Table 3. Interrupted time series analysis changes in slope and level of crude and standardized CT ratio and hospital admissions

	Slope 2007-2009 (p value)	Change in level after introduction of new guideline (p value)	Change in slope 2012-2015 (p value)
Crude CT ratio	0.18 (0.27)	19.84 (0.04)	-0.01 (0.94)
Standardized CT ratio	0.48 (0.08)	31.85 (0.05)	-0.21 (0.50)
Hospital admissions	0.29 (0.13)	8.32 (0.43)	-0.23 (0.31)

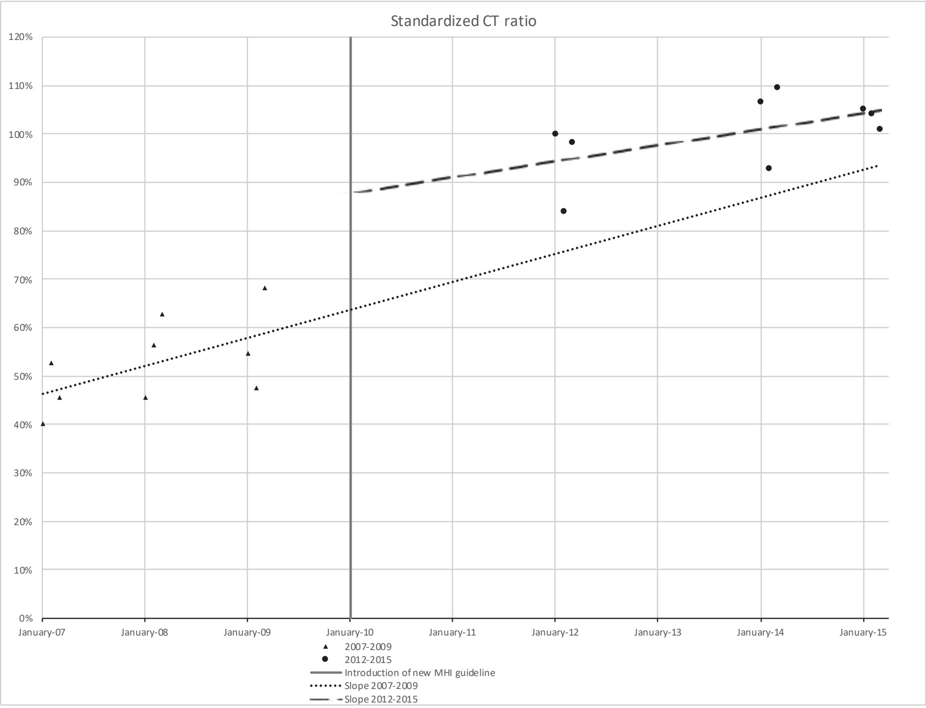

Figure 1.

Interrupted time series analysis changes in slope and level of standardized CT ratio.

This figure shows the standardized CT ratio per month before (triangles) and after (rounds) introduction of the guideline. It also shows the secular trend (slope) in standardized CT ratio before (dotted line) and after (striped line) introduction of the guideline.

Discussion

In this study we found an increase in both the use of CT-scans as well as hospital admissions in patients with MHI, not sufficiently explained by the increase in (intra) cranial traumatic findings.

This is in contrast with the expectation that introduction of the guideline would reduce the number of CT scans as well as the number of hospital admission. A CT reduction of 20-32% was estimated beforehand. Instead of confirming this reduction, we found an increase of 30.4%. A major cause of this increase seems to be the implementation of the new guideline as was demonstrated in the ITS analysis. However, this is probably not the only cause as we also observed a (not statistically significant) secular trend of an increasing standardized CT ratio each year. Easy access to CT scans, more defensive healthcare in general, and emergency department crowding are possible causes of this secular trend. Besides this the CT ratio in the Netherlands is still relatively low in international perspective, where CT ratios for MHI are generally around 65-80%.[7,17,18] Remarkably the implementation trial after introduction of the Canadian CT Head Rule showed similar results, an increase in CT ratio.[17,19] The authors argued this effect was, for the most part, attributable to poor physician adherence to the guideline.[17] However, in our study lack of guideline adherence does not seem to be an important contributing factor with an adherence of 84.1% and an average standardized CT ratio of 100.5% after implementation of the guideline. This is a better guideline adherence than other proposed guidelines for MHI.[17,20]

The increase in CT ratio did not result in less hospitalization, on the contrary. Besides more CT-scans performed, also the proportion of patients admitted to the hospital increased between 2007 and 2015. This was also an unexpected result, since the new guideline dictates that hospitalization is (generally) no longer necessary when the CT-scan shows no traumatic abnormalities. The observed increase in hospital admission ratio may be partially explained by the abandonment of home waking advice in the new guideline. Before introduction of the guideline home waking advice used to be daily routine in certain patients, also when the CT-scan was normal. Home waking advice comprises of regularly waking the patient in the home setting, to make sure he or she is doing well. Because of lack of evidence this advice is no longer part of the new guideline. It is possible that Dutch physicians, instead of discharging the patient, chose for hospitalization for clinical observation.

From the viewpoint of cost-effectiveness there seems to be a lot to gain. The number of CT-scans performed has risen significantly. Moreover, costs are piling up even more with the growth in hospitalizations. Careful evaluation of each admission and CT-scan is therefore needed. A multimodal intervention focusing on physicians could be of importance to reduce CT ratio, as was shown in community hospitals in the USA. [21] Furthermore, adjustment of the guideline should be considered. Examples of such adjustments that could be considered are a higher threshold for performing a CT-scan, more emphasis on clinical judgement or the implementation of other diagnostic modalities such as biomarkers to reduce CT ratio.

The retrospective study design has certain limitations. Missing data were presumed to be absent. For example: if vomiting was not mentioned in the electronic patient record, we presumed absence. This could introduce bias while determining the major and minor criteria for performing a CT-scan. However, this bias would be present in all years studied, and should not be of noteworthy effect for our primary and secondary outcomes. Demonstrating a causal link is also impossible with the retrospective design. Another limiting factor is the possibility of missing traumatic findings in patients who did not undergo a CT. Subsequently it is not possible to draw conclusions about whether too few CT-scans were performed in 2007-2009, or too many were performed in 2012-2015. In line with these limitations, our study was not designed to prove which situation (2007-2009 or 2012-2015) was better in the context of patient safety.

Between 2007 and 2015, a marked increase in CT ratio for MHI as well as hospitalizations has been observed. Several factors seem to contribute to this increase. Most likely, introduction of the MHI guideline is an important contributor at least to the increase in CT ratio. Since health care is getting more expensive and cost-effectiveness more important, an adjustment to the guideline should be considered.

Acknowledgments
We thank A.H.J.H. (Annelijn) Rambach, Roelie Postma, Victoria L. van de Craats, Frank Lengers, Christa P. Bénit and Femke C. Verbree, for their valuable contribution to patient data collection.

References

1. van den Brand CL, Karger LB, Nijman STM, Hunink MGM, Patka P, Jellema K. Traumatic brain injury in the Netherlands, trends in emergency department visits, hospitalization and mortality between 1998 and 2012. Eur J Emerg Med 2018; 25 (5):355-361.
2. Foks KA, van den Brand CL, Lingsma HF, van der Naalt J, Jacobs B, de Jong E, et al. External validation of computed tomography decision rules for minor head injury: prospective, multicentre cohort study in the Netherlands. Bmj 2018; 362:k3527.
3. Smits M, Dippel DW, Steyerberg EW, de Haan GG, Dekker HM, Vos PE, et al. Predicting intracranial traumatic findings on computed tomography in patients with minor head injury: the CHIP prediction rule. Ann Intern Med 2007; 146 (6):397-405.
4. af Geijerstam JL, Britton M. Mild head injury - mortality and complication rate: meta-analysis of findings in a systematic literature review. Acta Neurochir (Wien) 2003; 145 (10):843-850; discussion 850.
5. af Geijerstam JL, Britton M. Mild head injury: reliability of early computed tomographic findings in triage for admission. Emerg Med J 2005; 22 (2):103-107.
6. Berrington de Gonzalez A, Mahesh M, Kim KP, Bhargavan M, Lewis R, Mettler F, et al. Projected cancer risks from computed tomographic scans performed in the United States in 2007. Arch Intern Med 2009; 169 (22):2071-2077.
7. DeAngelis J, Lou V, Li T, Tran H, Bremjit P, McCann M, et al. Head CT for Minor Head Injury Presenting to the Emergency Department in the Era of Choosing Wisely. West J Emerg Med 2017; 18 (5):821-829.
8. Stiell IG, Wells GA, Vandemheen K, Clement C, Lesiuk H, Laupacis A, et al. The Canadian CT Head Rule for patients with minor head injury. Lancet 2001; 357 (9266):1391-1396.
9. Haydel MJ, Preston CA, Mills TJ, Luber S, Blaudeau E, DeBlieux PM. Indications for computed tomography in patients with minor head injury. N Engl J Med 2000; 343 (2):100-105.
10. Bouida W, Marghli S, Souissi S, Ksibi H, Methammem M, Haguiga H, et al. Prediction value of the Canadian CT head rule and the New Orleans criteria for positive head CT scan and acute neurosurgical procedures in minor head trauma: a multicenter external validation study. Ann Emerg Med 2013; 61 (5):521-527.
11. Papa L, Stiell IG, Clement CM, Pawlowicz A, Wolfram A, Braga C, et al. Performance of the Canadian CT Head Rule and the New Orleans Criteria for predicting any traumatic intracranial injury on computed tomography in a United States Level I trauma center. Acad Emerg Med 2012; 19 (1):2-10.
12. Smits M, Dippel DW, de Haan GG, Dekker HM, Vos PE, Kool DR, et al. External validation of the Canadian CT Head Rule and the New Orleans Criteria for CT scanning in patients with minor head injury. Jama 2005; 294 (12):1519-1525.
13. Stiell IG, Clement CM, Rowe BH, Schull MJ, Brison R, Cass D, et al. Comparison of the Canadian CT Head Rule and the New Orleans Criteria in patients with minor head injury. Jama 2005; 294 (12):1511-1518.
14. Smits M, Hunink MG, Nederkoorn PJ, Dekker HM, Vos PE, Kool DR, et al. A history of loss of consciousness or post-traumatic amnesia in minor head injury: "conditio sine qua non" or one of the risk factors? J Neurol Neurosurg Psychiatry 2007; 78 (12):1359-1364.
15. Hageman G, Pols MA, Schipper DM, Boerman RH, Cremers JPM, van Dijk KGJ. Richtlijn licht traumatich hoofd/hersenletsel (LTH). Federatie Medisch Specialisten; 2010.

16. Kontopantelis E, Doran T, Springate DA, Buchan I, Reeves D. Regression based quasi-experimental approach when randomisation is not an option: interrupted time series analysis. Bmj 2015; 350:h2750.
17. Stiell IG, Clement CM, Grimshaw JM, Brison RJ, Rowe BH, Lee JS, et al. A prospective cluster-randomized trial to implement the Canadian CT Head Rule in emergency departments. Cmaj 2010; 182 (14):1527-1532.
18. Venkatesh AK, Scofi JE, Rothenberg C, Berdahl CT, Tarrant N, Sharma D, et al. Choosing wisely in emergency medicine: Early results and insights from the ACEP emergency quality network (E-QUAL). Am J Emerg Med 2020.
19. Stiell IG, Bennett C. Implementation of clinical decision rules in the emergency department. Acad Emerg Med 2007; 14 (11):955-959.
20. Heskestad B, Baardsen R, Helseth E, Ingebrigtsen T. Guideline compliance in management of minimal, mild, and moderate head injury: high frequency of noncompliance among individual physicians despite strong guideline support from clinical leaders. J Trauma 2008; 65 (6):1309-1313.
21. Sharp AL, Huang BZ, Tang T, Shen E, Melnick ER, Venkatesh AK, et al. Implementation of the Canadian CT Head Rule and Its Association With Use of Computed Tomography Among Patients With Head Injury. Ann Emerg Med 2018; 71 (1):54-63.e52.

Supplementary Material

Supplementary Table 1. Patients with (possible) missed traumatic findings

Patient	Year	PTA, LOC, confusion[1]	GCS[1]	CT indication[2]
A	2007	Yes LOC, PTA	15	No[3]
B	2009	No	15	Yes[4]
C	2012	Yes LOC, PTA	14	Yes[5]
D	2014	No	15	Yes[6]

PTA: post traumatic amnesia; LOC: loss of consciousness; GCS: Glasgow Coma Scale score
[2] According to the guideline introduced in 2010.
[3] Age < 40 years, no external injury to the head, LOC, PTA < 2 hours, no other risk factors.
[4] Age ≥ 40 years, external injury to the head, anticoagulants.
[5] Age ≥ 40 years, external injury to the head, LOC, GCS 14, PTA < 2 hours.
[6] Age ≥ 40 years, external injury to the head, anticoagulants. A CT head was not performed for unclear reasons.

Supplementary Table 2. Crude and standardized CT ratio per year, hospital admission per year

	2007	2008	2009	2012	2014	2015
Crude CT ratio %	24.2	22.2	27.0	51.6	55.6	57.8
CT indication %	52.5	41.0	49.0	54.3	54.1	55.7
Standardized CT ratio %	46.2	54.2	55.1	94.9	102.9	103.8
Hospital admissions %	10.3	16.0	16.9	23.1	19.8	27.4

Supplementary Table 3. Guideline adherence (years 2012, 2014, 2015)

	CT indicated according to guideline	CT not indicated according to guideline
CT performed	964 (85.7%)	167 (17.9%)
CT not performed	161 (14.3%)	765 (82.1%)

3

CT on first ED visit	CT on repeat ED visit (within 30 days)	Clinical course
No CT on first visit	Day 2: epidural hematoma with midline shift, skull fracture	Neurosurgical intervention, full recovery
No CT on first visit	Day 3: parenchymal contusion, acute subdural hematoma	Conservative treatment, patient died of a non-neurologic cause on day 16
Yes, no traumatic findings on first CT	Day 10: acute subdural hematoma with midline shift	Several neurosurgical interventions, patient died of a non-neurologic cause on day 27
No CT on first visit	No repeat ED visit	Patient died of an unknown cause on day 7