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C-Spine Immobilization in Trauma: Are We Doing It Right? A Survey amongst Prehospital Caregivers in Flanders, Belgium

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ABSTRACT

Background

Applying cervical collars to patients with suspected cervical spine (C-spine) injuries is common practice in prehospital care. Because of the controversy surrounding C-spine immobilization and the proven benefits of C-spine clearance, it is our aim to establish an overview of the current practices and assess whether the algorithms for C-spine clearance are applied correctly.

Methods

A survey was conducted amongst prehospital caregivers in Flanders, Belgium. Ten trauma cases were presented. Adherence to the three most commonly used protocols, National Emergency X-Radiography Utilization Study (NEXUS), Canadian C-spine Rule (CCR) and prehospital trauma life support (PHTLS) was verified.

Results

This study included 980 responses. A protocol was used by 43.0% of the respondents. The majority used PHTLS (46.8%), followed by CCR (20.4%) and NEXUS (16.9%). Overall, 42.4% of protocol users did not meet our 8/10 pass mark for adherence. PHTLS users adhered significantly better, 29.4% scored below 8/10. CCR and NEXUS users had the lowest adherence, respectively 60.5% and 56.3% scored below 8/10. The collar was applied for the wrong main reason by 73.6% of the protocol users. The main errors were undershooting errors (42.6%).

Conclusion

Most prehospital caregivers do not use a protocol for C-spine immobilization. Adherence to protocols is poor. Criteria for immobilization are insufficiently recognized. Undershooting could result in failure to recognize injuries, leading to inappropriate treatment and consequent body damage. Better knowledge of protocols and training is recommendable to increase patient comfort, reduce unnecessary imaging costs and limit needless radiation exposure. Implementation of a single countrywide protocol could decrease confusion amongst caregivers and thereby improve their efficiency and self-confidence.

Keywords

Spinal immobilization; Trauma; Prehospital care; Survey; Emergency medicine.

BACKGROUND

Applying cervical collars to patients with suspected cervical spine (C-spine) injuries is common practice in prehospital care. These collars aim to immobilize a potentially unstable spine, thus preventing secondary injury to the spinal cord since spinal cord damage causes long-term disability and can dramatically affect quality of life.[1]

The supporting evidence of its benefits is weak and randomized controlled trials are missing. However, concerns have been raised against the use of cervical collars, as they insufficiently reduce cervical spine movement, decrease patient comfort and might have negative effects on intracranial pressure.[2-15]

Immobilization could cause false-positive exams and thus prevent the clinical clearance of the C-spine, therefore requiring imaging studies to exclude traumatic spine injury.[16] Unnecessary imaging causes a significant financial burden on healthcare systems and can often be prevented by evidence-based guidelines

for clearance of the cervical spine. Furthermore, this avoidable radiation exposure unnecessarily increases the risk of cancer.[17] The 2006 Biological effects of ionizing radiation (BEIR) VII lifetime attributable cancer risk model predicts that 1 in 1000 persons exposed to a single diagnostic computerized tomography (CT) of the neck will develop cancer due to that single exposure.[18] This has driven organizations and hospital networks to develop spinal immobilization guidelines excluding the use of the cervical collar, favoring spinal movement restriction over immobilization. For instance, in Belgium, the Red Cross of Flanders and the Antwerp University Hospital no longer recommend the use of a cervical collar to their prehospital caregivers.[19]

At present, in general prehospital caregivers in Belgium are taught to use cervical collars for spinal immobilization. Advanced trauma life support (ATLS) and prehospital trauma life support (PHTLS) guidelines feature the use of cervical collars and find use amongst physicians and emergency nurses.[20,21] For emergency medical technicians (EMTs) the official handbook dictates the use of a cervical collar for every suspicion of traumatic spine injury.[22] A clear set of clinical signs and concerning mechanisms of injury is not provided. Furthermore, a pragmatic guideline is lacking and validated clinical screening tools for cervical spine injury are not mentioned.

Different algorithms are available for the clearance of the cervical spine. The National Emergency X-Radiography Utilization Study (NEXUS), Canadian C-spine rule (CCR) and the PHTLS guidelines are employed regularly.[23] Studies have shown that NEXUS and CCR can be safely used by physicians, nurses and paramedics to rule out cervical spine injury.[24-28] Training of prehospital caregivers in the clinical clearance of the C-spine safely reduces the amount of immobilization and consequently the need for imaging.[29-35] Norway and Denmark have recently recognized the value of a clinical screening protocol and consequently issued national standardized guidelines for the prehospital management of adult trauma patients with potential cervical spine injury.[36,37]

In light of the emerging controversy surrounding C-spine immobilization and the proven benefits of C-spine clearance in the prehospital setting, this study aims to map the current practice in Belgium by means of a questionnaire and to assess whether the protocols for C-spine clearance are correctly applied.

METHODS

Study Design

A prospective, cross-sectional survey was performed amongst Belgian prehospital caregivers. The primary aim of the survey was to map the current practice of C-spine immobilization in Belgium. The secondary aim was to investigate whether the protocols for C-spine clearance are used as prescribed.

Participants and Distribution

Caregivers working in Belgian prehospital emergency care with the title of first aider, EMT, nurse, emergency nurse or physician were asked to complete the survey. The participants were anonymously questioned through an online questionnaire using the Qualtrics platform (version of September 2019, the Qualtrics Company, Provo, UT, USA).[38] The survey was sent *via* social media and *via* e-mails to emergency departments, fire departments and ambulance services with public e-mail addresses and multiple associations such as EMT training institutes, the Flemish Association of Emergency Nurses (VVVS) and the Union for EMTs (Ambulanciersunie) which spread the participation requests to their members. The questionnaire was open for answers from July 15th 2019 up to September 16th 2019. Periodic reminders were sent.

Survey Design

With the input of experienced field personnel, ten trauma cases were constructed based on actual prehospital experiences. For each case, participants were asked whether they would immobilize the cervical spine of the patient. All cases were designed in such a manner that the answers resulted in a clear positive or negative response according to the three most commonly used clinical clearance tools: NEXUS, CCR and PHTLS. A clear positive or negative answer, meant that the protocol that was followed concluded that the cervical spine should or should not be immobilized respectively. In five cases each of the tested protocols resulted in an identical answer. In the other five cases, one protocol would always yield an answer different from the other two protocols. This difference allowed assessment of both the knowledge and the correct application of the protocol.

In case of a positive answer, the main reason for cervical collar application was questioned (multiple choice). In the final section, the respondent was asked whether he/she used a protocol for C-spine immobilization and which protocol was used. The questionnaire concluded with demographic data of the respondent (education, age, work experience and geographical area of activity).

Data Management and Statistical Analyses

Statistical analyses were performed using IBM® statistical package for the social sciences (SPSS) Statistics for Windows, Version 25.0 (IBM Corp, Armonk, NY, IBM Corp). For each question asked, the answers were cross tabulated with the selected protocol. For all participants the number of applied cervical collars was analyzed and compared to the selected protocol. For each participant using PHTLS, CCR or NEXUS, answers were compared to a predetermined set of correct answers and the total score was calculated.

A cross correlation analysis for education, age, years of experience and region of work activity was performed using an independent-samples Kruskal-Wallis test. If a test yielded a significant difference in distribution of scores between these selected parameters, a pairwise comparison was performed to identify differences. Cases with a score below 80% were further analyzed to see whether the correct reasons were used for applying the collar. Incorrect answers were analyzed per protocol to define under- and overshooting errors. Correct collar application answers were analyzed to define if the correct reason had been

used according to the selected protocol. A p-value<0.05 was considered statistically significant. The pass mark for total scores in collar applications was set at 8/10. Partially completed surveys were excluded from the data analysis. No a priori sample size was calculated.

For the descriptive statistics and the creation of graphs and other illustrations, Microsoft Excel (2018), Qualtrics software and IBM® SPSS Statistics were used.

RESULTS

In total 1247 survey responses were collected of which 989 (79.3%) surveys were complete and 980 met the inclusion criteria. The majority of the participants were EMTs based in Flanders. The median age and experience in prehospital care of the respondents were 35-years (range: 18-68-years) and 8-years (range: 0-49 years), respectively. The demographic characteristics are presented in Table 1.

Table 1. *Population Characteristics (n=980)*

	Number (%)
Education/Function	
EMT	624 (63.7)
Emergency nurse	249 (25.4)
Nurse	52 (5.3)
Emergency physician	19 (1.9)
Resident emergency medicine	17 (1.8)
First Aider	8 (0.8)
Anesthesiologist	7 (0.7)
Medical doctor of any other specialty	4 (0.4)
Geographical Region of Work Activity	
Vlaams-Brabant	232 (23.7)
West-Vlaanderen	215 (21.9)
Antwerpen	186 (19.0)
Limburg	179 (18.3)
Oost-Vlaanderen	152 (15.5)
Brussel	13 (1.3)
Henegouwen	1 (0.1)
Luik	1 (0.1)
Waals-Brabant	1 (0.1)
Use of a Spinal Immobilization Protocol	
Yes	426 (43.5)
No	554 (56.5)
Which Spinal Immobilization Protocol is Used	
PHTLS	196 (46.6)
CCR	86 (20.4)
NEXUS	71 (16.9)
SO EMT	22 (5.2)
Local protocol	9 (2.1)
Other	37 (8.8)

Of all respondents, 421 (43.0%) confirmed the use of a protocol for cervical spine immobilization. The majority used PHTLS (46.8%) followed by CCR (20.4%) and NEXUS (16.9%). The remaining 15.9% used less-common protocols: Belgian standing orders for EMTs (SO EMT) (5.0%), local hospital protocols (2.4%) (e.g. the trauma protocol of Antwerp University Hospital) or other protocols (8.6%). Respondents in the category 'other protocols' claimed to be using a protocol which was either unidentifiable, a combination of NEXUS and CCR or a protocol used in the Netherlands. EMTs, nurses and emergency nurses whom were using a protocol mainly used PHTLS (47.3%, 40.0% and 54.3% respectively). For EMTs and nurses (18.6% and 20.0%, respectively) NEXUS was the second most used protocol, while for emergency nurses CCR was the second most used protocol (21.7%). The large majority of the physicians used CCR (64.3%) followed by NEXUS (14.3%) and PHTLS (10.7%).

Analysis of the number of cervical collars applied by protocol showed caregivers using CCR were most restrictive, with an average of 29.1% of cervical collars applied in the ten cases. Caregivers using NEXUS applied the most collars (45.2%), followed by caregivers using PHTLS (34.2%). When looking at less-commonly used protocols, users of the standing orders for EMTs applied the most collars (39.1%), followed by local hospital protocols (18.9%).[39] Overall, local protocol users seemed to apply the fewest cervical collars. In comparison, 34.0% of caregivers who did not use a specific protocol for C-spine clearance applied a collar.

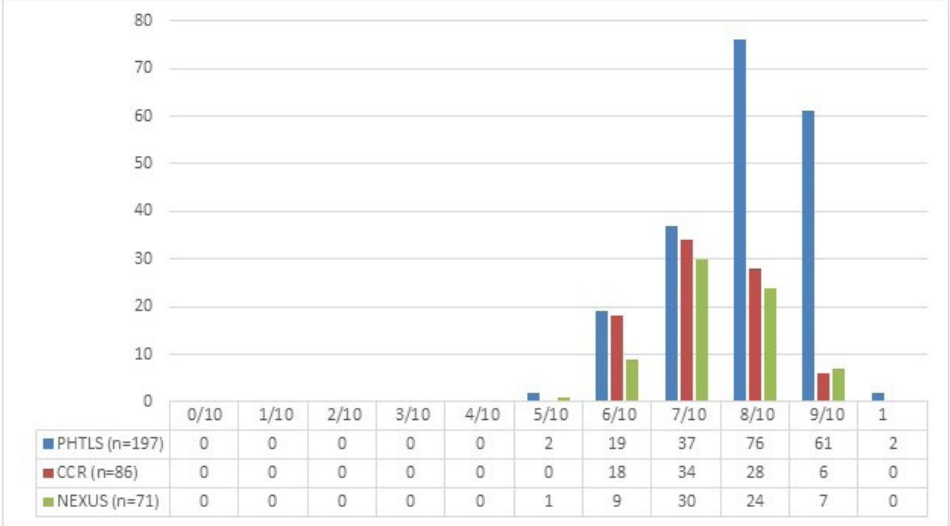
Of all respondents using a protocol, 42.4% had a score below 8/10 (Figure 1). The overall score was never below 5/10. Caregivers using CCR had the lowest scores with 60.5% having a score lower than 8/10, followed by 56.3% of caregivers using NEXUS and 29.4% of caregivers using PHTLS. Pairwise comparison of the protocols using an independent-samples Kruskal-Wallis test showed significantly higher overall scores for respondents using the PHTLS protocol, compared to CCR and NEXUS (p<0.05) (Figure 2a). There was no statistically significant difference in scores between CCR and NEXUS (p=0.443).

No statistically significant correlation was found for the level of education and obtained scores. The independent-samples Kruskal-Wallis test for cross-correlation with region of work activity showed that the best scores were obtained in the provinces of Vlaams-Brabant and Brussels Capital Region (Figure 2b). Correlation analysis for age showed a trend towards higher scores with higher age, but this trend was not statistically significant (p=0.067). No correlation was found with the number of years of experience (p=0.221).

The percentage of correct answers was grouped per protocol for each case. In five cases the adherence according to at least one of the protocols was below 80.0%: Q2, Q5, Q6, Q7 and Q8. For each protocol, the adherence was below 80.0% for 3 out of 10 cases. Analysis of the incorrect answers revealed that most errors were undershooting errors, i.e., not applying a cervical collar while the used protocol mandates its application (Figure 3).

In 4 out of 10 cases, respondents should have applied the cervical collar according to the protocol they were using. Next, we

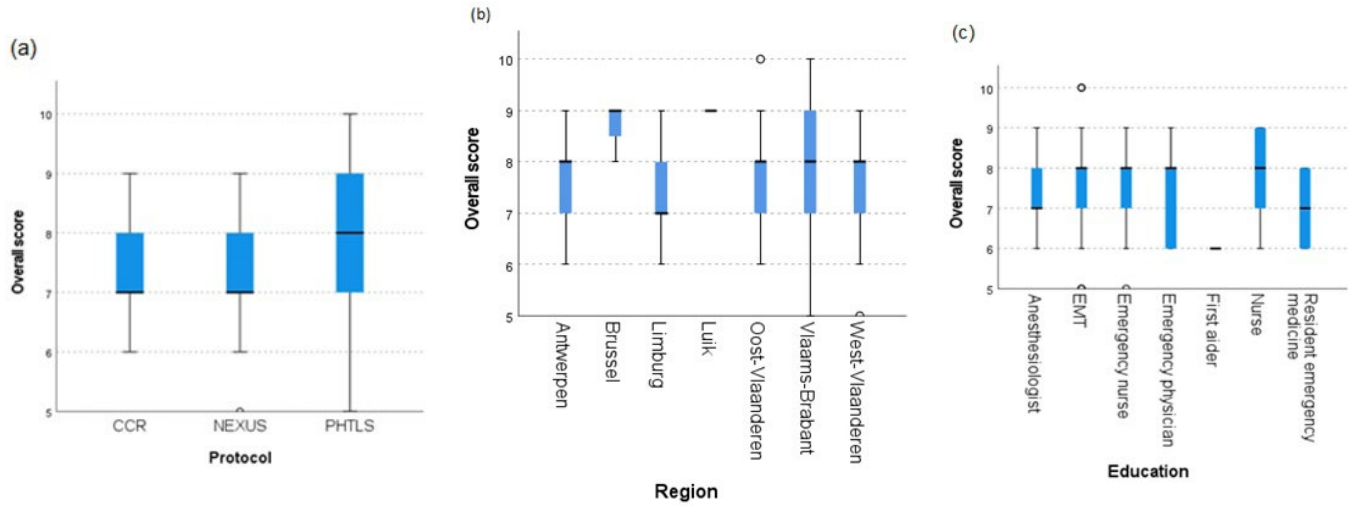
Figure 1. *Number of Correct Survey Answers per Protocol Used*



	0/10	1/10	2/10	3/10	4/10	5/10	6/10	7/10	8/10	9/10	1
PHTLS (n=197)	0	0	0	0	0	2	19	37	76	61	2
CCR (n=86)	0	0	0	0	0	0	18	34	28	6	0
NEXUS (n=71)	0	0	0	0	0	1	9	30	24	7	0

Blue: Prehospital Trauma Life Support (PHTLS) (n=197); Red: Canadian C-Spine Rule (CCR) (n=86); Green: National Emergency X-radiography Utilization Study (NEXUS) (n=71).

Figure 2. *Independent-Samples Kruskal-Wallis Tests*



(a) Correlation of total scores with adherence to protocols *(b) Correlation of total scores with region of work activity* *(c) Correlation of total scores with educational background*

checked whether the respondents chose the correct reasons to do so. When the collar was applied correctly, a strikingly high level of incorrect reasons for applying the collar was found. On average only 32.9% of caregivers using PHTLS, 46.8% of caregivers using NEXUS and 65.6% of caregivers using CCR applied the collar for the correct reason. When combining the correct decision to apply the collar and the correct reasoning behind it, average scores dramatically dropped to 23.5% (PHTLS), 26.8% (NEXUS) and 31.7% (CCR) (Table 2).

Overview per column. First column: cases where a cervical collar should be applied according to the protocol used; second column: number of caregivers that correctly decided to apply the cervical collar; third column: number of caregivers that chose the correct reason for applying the collar; fourth column: number of caregivers that correctly decided to apply the cervical collar for the right reasons.

DISCUSSION

To our knowledge, this survey was the first study in Flanders mapping the use of C-spine immobilization protocols for the application of cervical collars by prehospital caregivers. We found that 56.5% of the surveyed prehospital healthcare providers do

Figure 3. *Average Percentage of Under- and Overshooting Errors Per Protocol*

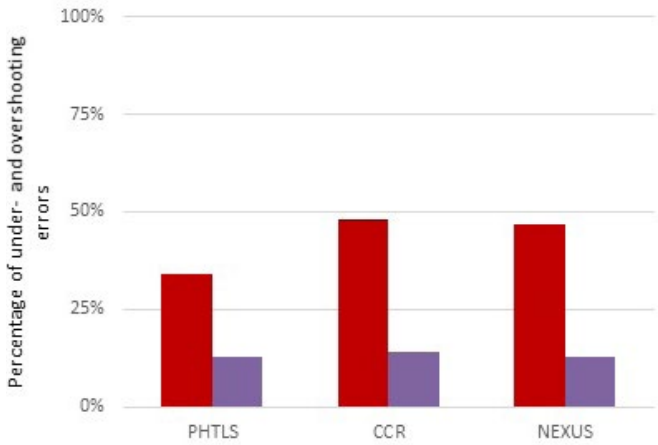


Table 2. *Overview of the Number of Correct Cervical Collar Applications and the Reasoning Behind*

	Correct Decision to Apply Collar	Correct Reason to Apply Collar	Correct Decision Combined with Correct Reasoning
PHTLS (n=197)			
Q3	169/197 (85.8%)	9/169 (5.3%)	9/197 (4.6%)
Q5	30/197 (15.2%)	7/30 (23.3%)	7/197 (3.6%)
Q8	137/197 (69.5%)	64/137 (46.7%)	64/197 (32.5%)
Q9	187/197 (94.9%)	105/187 (56.1%)	105/197 (53.3%)
Average	66.4%	32.9%	23.5%
CCR (n=86)			
Q3	73/86 (84.9%)	49/73 (67.1%)	49/86 (57.0%)
Q6	13/86 (15.1%)	10/13 (76.9%)	10/86 (11.6%)
Q7	15/86 (17.4%)	11/15 (73.3%)	15/86 (17.4%)
Q9	78/86 (90.7%)	35/78 (44.9%)	35/86 (40.7%)
Average	52.03%	65.6%	31.7%
NEXUS (n=71)			
Q2	13/71 (18.3%)	2/13 (15.4%)	2/71 (2.8%)
Q3	63/71 (88.7%)	27/63 (42.9%)	27/71 (38.0%)
Q5	9/71 (12.7%)	6/9 (66.7%)	6/71 (8.5%)
Q9	66/71 (93.0%)	41/66 (62.1%)	41/71 (57,7%)
Average	53.2%	46.8%	26.8%

not use a protocol for C-spine clearance. Caregivers who do use a protocol, mainly use PHTLS, CCR and NEXUS. The PHTLS protocol has the most widespread use (46.6%) and is mainly used by EMTs and nurses. The CCR is the main protocol used by physicians (64.3%) and is more frequently used by emergency nurses (21.7%). What is striking in these results is the large heterogeneity in approach to C-spine immobilization. Many respondents do not use a protocol at all and those who do use a protocol, use a large variety. This can lead to confusion and discordance between caregivers in the decision to immobilize a patient.

Based on ten realistic trauma cases, a first assessment was made whether respondents, according to the protocol they used, correctly decided whether or not to apply a collar. All respondents treated at least 5 out of 10 cases correct. However, only 57.6% of the caregivers met the pass mark of 8/10. Analysis of the cases where the wrong decision to immobilize was made, shows a rather high level of undershooting errors, meaning that no C-spine collar is applied whilst the protocol dictates application. In a prehospital care environment, one would expect a cautious approach, resulting in overshooting. Our findings contradict this expectation. The observed high level of undershooting errors could result in the failed recognition of cervical spine injuries, leading to misappropriate treatment and consequent body damage.

In a second phase, we investigated whether the respondents used the correct reasons for immobilization according to the protocol they were using. A strikingly high level of incorrect

reasons for applying the collar was found. It thus seems that protocol knowledge is largely insufficient.

Several elements of the different protocols are insufficiently recognized as a key reason to immobilize. For PHTLS users, alcohol intoxication and communication barriers were poorly recognized. For CCR, elderly age and bike collision as mechanism of injury were insufficiently picked up. Finally, NEXUS users did not recognize alcohol intoxication and distracting injuries as reasons for applying the collar. Overall, users of all protocols confused elements of the various protocols, stating the use of one protocol but selecting a reason to apply the collar unique for another protocol.

These findings suggest considerable knowledge gaps and confusion amongst healthcare workers using the different most widespread protocols. This was also seen in a German study by Kreinest et al. Their survey of 465 paramedics showed that standardized algorithms facilitate teamwork and improve self-confidence and highlighted the need for a general protocol for the prehospital treatment of spinal injuries.[40]

Remarkably, caregivers who are not using any protocol demonstrated nearly the same frequency of collar applications. It would appear that caregivers who do not adhere to protocols have well-identified the multiple parameters for C-spine evaluation and arrive at the same frequency of collar applications as caregivers following PHTLS, CCR or NEXUS. Possibly the co-existence of the many protocols has resulted in the creation of personal use criteria, extracted from the decisive parameters of PHTLS, CCR and NEXUS. Only a very small group of providers (n=9) following local protocols were more restrictive. Insight in these local protocols showed that cervical collars are no longer used here and have been replaced by other means of spinal immobilization such as head-blocks on a vacuum mattress or rigid spinal board. The existence of numerous different methods for spinal immobilization may thus also be a confounder leading to poor scores.

The recent questioning of the benefits of spinal immobilization and the recognition of its potential in harming the patient add to the controversy. More in-depth knowledge of these protocols or the implementation of one national standardized protocol could eliminate these deficiencies.

STRENGTHS AND LIMITATIONS

A strength of this survey was the numerous responses by EMTs and nurses. This was made possible by the support of EMT training institutes, the union for EMTs and EMS services throughout Flanders. By using a case-based survey, we took a novel approach to assess the adherence to C-spine immobilization protocols. This study, however, has some limitations. As a survey, it is prone to response bias. The study cohort consisted primarily of EMTs, nurses and emergency nurses, while physicians were underrepresented. The ten cases were constructed artificially to detect knowledge of certain specific aspects of protocols and do not reflect the prevalence in real life of the cases presented. Moreover, ten cases is a small number for drawing wide carrying conclusions. Because the questionnaire was written in Dutch, we could not attain a national overview and thus our conclusions may only apply to Flanders. To make nationwide conclusions, a similar study should be repeated in both French and German. This cross-sectional study cannot comment on the clinical effectiveness of the cervical collar as a method for spinal immobilization. More research using controlled trials is required to answer this question.

CONCLUSION

Most prehospital caregivers in Flanders do not use a protocol for cervical spine immobilization using a cervical collar. Amongst caregivers using a protocol, multiple protocols are in use and protocol adherence is poor. These findings suggest that better protocol knowledge and training is recommended to help increase patient comfort, reduce unnecessary imaging costs and limit needless radiation exposure. Implementation of one countrywide standardized protocol and spinal immobilization technique is expected to decrease confusion amongst caregivers and thus improve their efficiency and self-confidence.

ETHICAL APPROVAL AND CONSENT TO PARTICIPATE

The Research Ethics Committee UZ/KU Leuven granted ethical approval for the study (MP010852). Participants were informed that participation was voluntary, that the collected information would be kept confidential and that the questionnaire was anonymous. Informed consent was waived and completion of the questionnaire was considered as granting permission for data collection.

AVAILABILITY OF DATA

Data available on request.

FUNDING

There was no funding source for this study.

AUTHOR'S CONTRIBUTION

GR constructed developed the study design, constructed the ten trauma cases and electronic survey, recruited participants through diverse channels, analyzed the statistical data and wrote the manuscript. DD advised and assisted in the statistical analyses of the data. DD also designed some of the figures with statistical data. LW reviewed the initial study design, proofread the manuscript with critical scientific advice on the discussion and conclusions. SV assisted and proofread in all parts of the making of this study. SV mentored GR in the design, execution and writing of this study.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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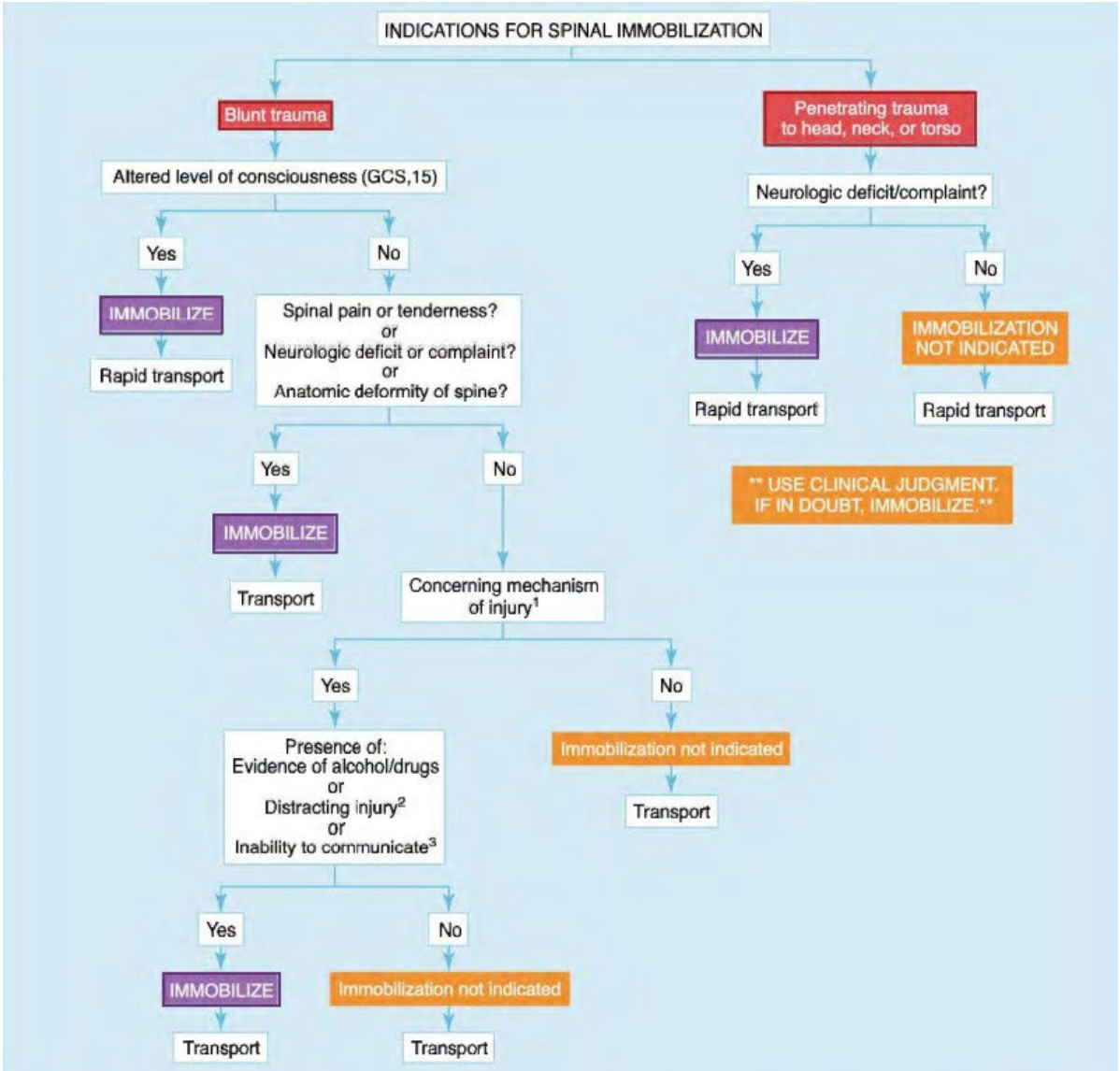
APPENDICES

Appendix I: Prehospital Trauma Life Support (PHTLS)[21]

Indications for Spinal Immobilization



Notes:

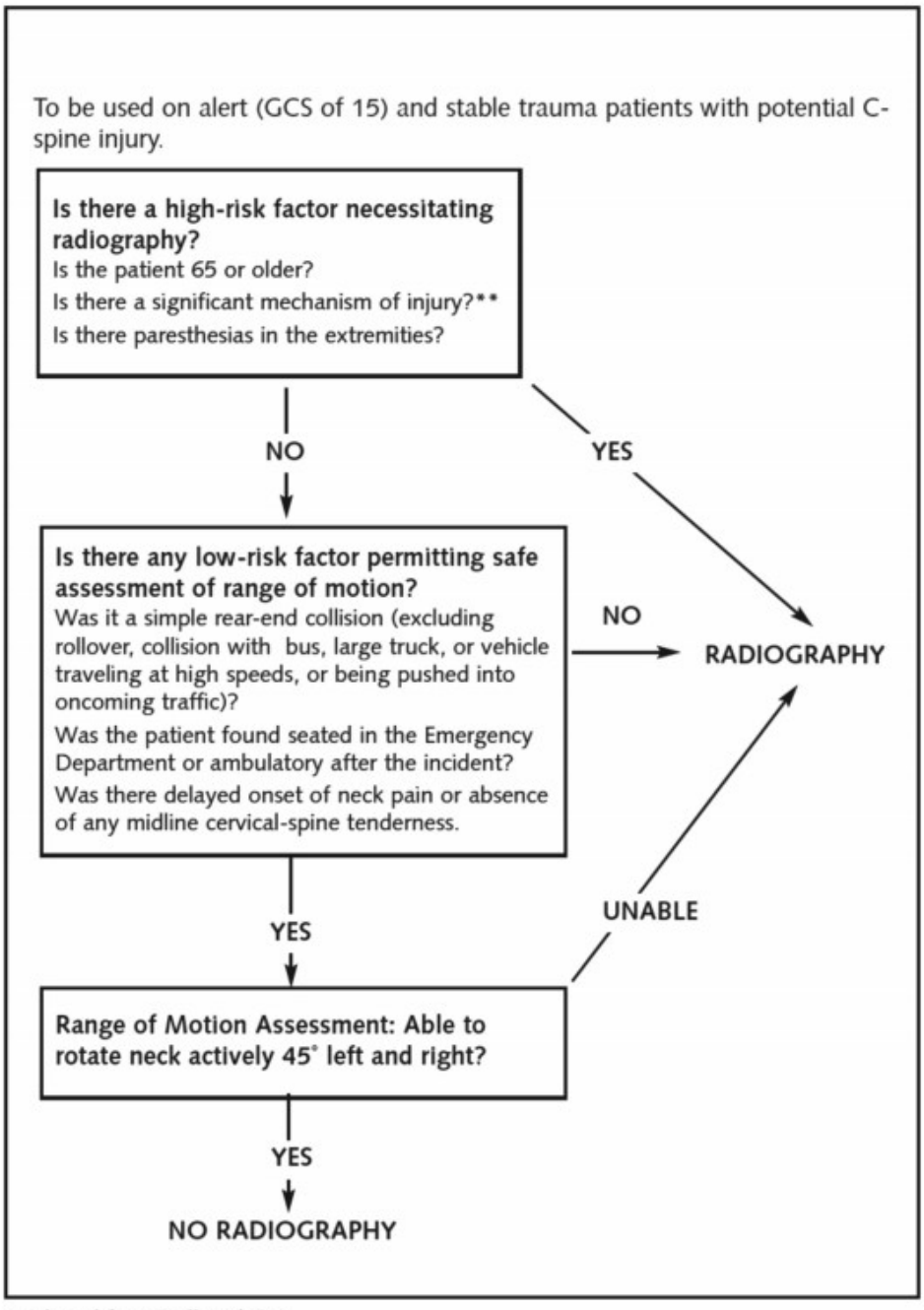
[1]Concerning mechanisms of injury
- Any mechanism that produced a violent impact to the head, neck, torso, or pelvis (e.g., assault, entrapment in structural collapse, etc.)
- Incidents producing sudden acceleration, deceleration, or lateral bending forces to the neck or torso (e.g., moderate- to high-speed MVC, pedestrian struck, involvement in an explosion, etc.)
- Any fall, especially in elderly persons
- Ejection or fall from any motorized or otherwise-powered transportation device (e.g., scooters, skateboards, bicycles, motor vehicles, motorcycles, or recreational vehicles)
- Victim of shallow-water diving incident

[2]Distracting injury
Any injury that may have the potential to impair the patient's ability to appreciate other injuries. Examples of distracting injuries include a) long bone fracture, b) a visceral injury requiring surgical consultation, c) a large laceration, degloving injury, or crush injury, d) large burns, or e) any other injury producing acute functional impairment.
(Adapted from Hoffman JR, Wolfson AB, Todd K, Mower WR: Selective cervical spine radiography in blunt trauma: methodology of the National Emergency X-Radiography Utilization Study [NEXUS], *Ann Emerg Med* 461, 1998.)

[3]Inability to communicate.
Any patient who, for reasons not specified above, cannot clearly communicate so as to actively participate in their assessment. Examples: speech or hearing impaired, those who only speak a foreign language, and small children.

Appendix II: Figure Illustrating the Canadian C-spine Rule (CCR)[1]

The Canadian C-spine Rule (CCR)



*Adapted from Stiell et al. 3,4

** A Dangerous Mechanism includes: a fall from an elevation ≥3 feet or 5 stairs; an axial load to the head (e.g. diving); a motor vehicle collision at high speed (>100 km/hr) or with rollover or ejection; a collision involving a motorized recreational vehicle; or a bike collision.

1. Stiell IG, Wells GA, Vandemheen KL, et al. The Canadian C-spine rule for radiography in alert and stable trauma patients. *JAMA.* 2001; 286(15): 1841-1848. doi: 10.1001/jama.286.15.1841

Appendix III: National Emergency X-Radiography Utilization Study (NEXUS) Criteria

The NEXUS Low Risk Criteria

C-spine imaging is recommended for patients with trauma unless they meet all of the following criteria:

- **Absence of posterior midline cervical-spine tenderness,#**
- **No evidence of intoxication,✵**
- **A normal level of alertness and consciousness (baseline mental status),◆**
- **Absence of focal neurological deficit,✲**
- **Absence of any distracting injuries.❍**

Midline posterior bony cervical-spine tenderness is present if the patient reports pain on palpation of the posterior midline neck from the nuchal ridge to the prominence of the first thoracic vertebra, or if the patient expresses pain with direct palpation of any cervical spinous process.

✵ Patients should be considered intoxicated if they have a recent history provided by the patient or an observer of intoxicating ingestion or evidence of intoxication on physical exam such as an odor of alcohol, slurred speech, ataxia, or any behavior indicative of intoxication. Patients may also be considered to be intoxicated if laboratory tests are positive for alcohol or drugs that affect the level of alertness.

◆ An altered level of alertness can include any of the following: a GCS score of 14 or less; disorientation to person, place, time, or events; inability to recall three objects at five minutes; a delayed or inappropriate response to external stimuli; or alternative findings consistent with altered mental status.

✲ A focal neurological deficit is any focal neurological finding on motor or sensory examination.

❍ A distracting injury is any condition that, in the examiner's judgment could be producing enough pain so as to distract the patient from another, particularly cervical, injury. Such injuries may include a long-bone fracture; a visceral injury; a significant laceration, degloving injury, or crush injury; large burns; or any other injury causing acute functional impairment.

Adapted from Hoffman and colleagues, as presented by Stiell et al., [4,9]

Fig. 1. The NEXUS low-risk criteria*.

Appendix IV: Original Questionnaire as Presented to the Study Participants

Q1.1

Dispatch information

You are called to the nightlife area of your city on a Friday evening for a stabbing incident. Law enforcement have been simultaneously alerted.

Situation on scene

The victim is sitting in the driver's seat of his car, law enforcement is present in large numbers.
General impression: 35-year-old male, confused, agitated, complaining of throat pain due to a stabbing with a knife. There was a dispute with another driver about a parking space.

Primary survey

A: Stridor.
B: Rapid and shallow breathing, bilateral breath sounds, SpO_2 91%, RR 26/min.
C: Stab wound 3 cm to the left of the larynx with severe bleeding. BP 140/80 mmHg, HR 110/min.
D: Awake, GCS 15/15, pupils equal and reactive to light, moves both arms and legs, blood glucose 102 mg/dL.
E: Throat pain, no abdominal tenderness or guarding.

Would you apply a cervical collar in this scenario?

o Yes
o No

Q1.2 Which element from this scenario made you decide to apply a cervical collar?

o Agitated state.
o Severe bleeding.
o Knife stab to the left of the larynx.
o Stridor.
o Respiratory rate of 26/min.

Q2.1

Dispatch information

You are called to an office building where a woman has slipped and complains of severe pain in the arm. The caller suspects the patient broke her arm.

Situation on scene

The victim is sitting in the hallway against the wall. She slipped on a wet floor. She fell backwards and tried to brace the fall with her arm. She fell from her own height on her head and arm.

Primary survey

A: Open and patent.
B: Tachypnea, bilateral breath sounds, SpO_2 97%, RR 21/min.
C: No external bleeding, BP 156/110 mmHg, HR 91/min.
D: Awake, GCS 15/15, no paresthesias.
E: No neck pain, abnormal position of the right forearm which is very painful (NRS 7/10).

Would you apply a cervical collar in this scenario?

o Yes
o No

Q2.2 Which element from this scenario made you decide to put on a cervical collar?

o Fall from own height on head and arm.
o Very painful right arm with suspected fracture.
o Tachypnea with a respiratory rate of 21/min.
o Slipped backwards.

Q3.1

Dispatch information

You are called to a student residence where someone fell through a skylight. It is 2:30 PM on a sunny spring day, outside temperature is 21 °C.

Situation on scene

The victim is lying on his back. He fell through the skylight while working on the roof and fell from a height of 3 meters.

Primary survey

A: Open and patent.
B: Tachypnea, bilateral breath sounds, SpO_2 90%, RR 24/min.
C: No external bleeding, pale and diaphoretic, BP 92/56 mmHg, HR 132/min.
D: Confused, GCS 11 (E3-M5-V3), pupils equal and reactive to light, moves both arms but is unable to move his legs, blood glucose is 124 mg/dL.
E: No cervical tenderness or pain, both legs are in exorotation, pelvic pain, multiple abrasions.

Would you apply a cervical collar in this scenario?

o Yes
o No

Q3.2 Which element from this scenario made you decide to apply a cervical collar?

o Fall from 3 meters height.
o Confusion with a GCS of 11 (E3-M5-V3).
o Inability to move his legs.
o Based on vital signs: BP 92/56 mmHg, HR 132/min, SpO_2 90%, RR 24/min.
o Legs in exorotation with pelvic pain.

Q4.1

Dispatch information

It is a rainy Sunday afternoon. You are dispatched to a sports terrain for an injury during a soccer match.

Situation on scene

The patient is sitting on the bench at the sideline. During a duel, a player stepped on the patient's foot. His foot was stuck while he kept advancing. Because weight-bearing was difficult during the rest of the match, he was substituted by another player. The patient's mother is very worried and has notified emergency services.

Primary survey

A: Patent.
B: Normal, bilateral breathing sounds, SpO_2 99%, RR 12/min.
C: No external bleeding, regular pulse, HR 67/min, BP 120/70 mmHg.
D: Awake, GCS 15/15, blood glucose 106 mg/dL.
E: Swollen painful right foot, especially when trying to bear weight, pain score NRS 3/10.

Would you apply a cervical collar in this scenario?

o Yes
o No

Q4.2 Which element from this scenario made you decide to apply a cervical collar?

o Injury during a soccer game.
o Impossible to bear weight on the foot.
o Concerned mother.
o Age of the patient (19-years-old)
o Pain score NRS 3/10.

Q5.1

Dispatch information

It is Friday night and you are dispatched to the terrace of a bar. During an argument, someone was allegedly beaten. Law enforcement are already present on scene.

Situation on scene

The victim is a 34-year-old man in an inebriated state. He is currently standing and talking to police offers. He was forcefully pushed with his head against the wall. He has asked the police to send an ambulance to evaluate his injuries.

Primary survey

A: Patent.
B: Normal, speaks spontaneously, SpO_2 98%, RR 13/min.
C: Regular pulse, HR 82/min, BP 134/78 mmHg.
D: Awake, GCS 15/15, no abnormal findings, blood glucose 112 mg/dL.
E: No neck pain, abrasions to the head and shoulder which are slowly bleeding, no sensory disturbances in the extremities.

Would you apply a cervical collar in this scenario?

o Yes
o No

Q5.2 Which element from this scenario made you decide to apply a cervical collar?

o Inebriated state.
o He was forcefully pushed with his head against the wall.
o Abrasions to the head and shoulder.
o Age of the patient (34-years-old).
o Based on the clinical neurological examination.

Q6. 1.

Dispatch information

On Easter Monday, your intervention is requested at a private residence. An older man has fallen.

Situation on scene

The victim is a 79-year-old man and you find him in the living room. Many family members are present. The victim is the grandfather of the family and has tripped over toys which were left lying around by the children. He fell on his side and had difficulties getting-up.

Primary survey

A: Patent.
B: Normal, speaks spontaneously, bilateral breathing sounds, SpO_2 98%, RR 13/min.
C: No external bleeding, regular pulse, HR 72/min, BP 137/81 mmHg.
D: Awake, GCS 15/15, blood glucose 102 mg/dL.
E: Abrasions to the head, tenderness to several ribs on the right, no abdominal rigidity, no neurological deficit, no neck pain, no paresthesias.

Would you apply a cervical collar in this scenario?

o Yes
o No

Q6.2 Which element from this scenario made you decide to apply a cervical collar?

o Age of the patient (79-years-old).
o Tripping and falling over toys.
o Tenderness at the level of several ribs.
o Abrasions to the head.
o Patient had difficulties getting up after falling.

Q7.1

Dispatch information

You are called to a traffic accident. Several cyclists were involved in a crash, but only one fell on the ground and suffered injuries. A number of cyclists are said to have collided with each other and one person has suffered a fall.

Situation on scene

At a busy bicycle intersection, several cyclists collided when someone made an unexpected maneuver. A 21-year-old man fell with his bicycle due to the collision. The victim is upright and is angry with the other cyclist. The handlebars of his bicycle are no longer straight in relation to his wheels and the frame is scratched.

Primary survey

A: Patent, speaks spontaneously.
B: Normal, SpO_2 100%, AF 12/min.
C: Well-beaten pulse with a regular rate, HR 74/min, BP 105/69 mmHg.
D: Awake, GCS 15/15, pupils equal and reactive to light, blood glucose 108 mg/dL.
E: Some bleeding abrasions on the forehead, left knee, leg and elbow.

Would you apply a cervical collar in this scenario?

o Yes
o No

Q7.2 Which element from this scenario made you decide to apply a cervical collar?

o Fall after collision between cyclists.

o Bleeding abrasions on the forehead, left knee, leg and elbow.
o Age of the patient (21-years-old).
o Based on the vital signs.
o Damaged bicycle after the accident.

Q8.1

Dispatch information

You are called to a bus depot at 5 PM on a Thursday afternoon. During the maintenance of the buses, a woman fell into the lubrication pit.

Situation on scene

Underneath a travel bus there is a lubrication pit. This pit is approximately half a meter deep. A woman, 32-years-old, is lying in the back of the pit in a supine position. You can easily access the pit. The victim is visibly in a lot of pain. She only speaks Hungarian and a few words of English. Communication with the victim is very inefficient.

Primary survey

A: Patent.
B: Normal and bilateral breathing sounds, RR 15/min, SpO_2 97%.
C: Tachycardia HR 98/min, pulse is strongly palpable and regular, BP 100/62 mmHg.
D: Awake, GCS 15/15, moves her 4 extremities, no sensory deficits.
E: No spinal tenderness, no neck pain, she can rotate her head to the left and right. She complains of pain in her shoulders and head. Medical examination is difficult due to the language barrier.

Would you apply a cervical collar in this scenario?

o Yes
o No

Q8.2 Which element from this scenario made you decide to apply a cervical collar?

o Age of the patient (32-years-old).
o Fall from a height of half a meter.
o Communication difficulties due to a language barrier (Hungarian) in combination with the fall.
o Pain at her head and shoulders.
o Can still rotate her head to the left and right.

Q9.1

Dispatch information

You are dispatched to a local lake. A group of young people went swimming and cliff diving in an unsupervised area.

Situation on scene

A 19-year-old male is sitting on the side of the water holding his neck. He complains of pain in the neck.

Primary survey

A: Patent.
B: Bilateral normal breathing sounds, RR 12/min, SpO_2 99%.
C: No external bleeding, regular pulse, HR 73/min, BP 115/74 mmHg.
D: Awake, GCS 15/15, blood glucose 107 mg/dL.
E: Cervical tenderness.

Would you apply a cervical collar in this scenario?

o Yes
o No

Q9.2 Which element from this scenario made you decide to apply a cervical collar?

o Age of the patient (19-years-old).
o Diving injury.
o Based on the vital signs.
o No external bleeding.
o Cervical tenderness.

Q10.1

Dispatch information

You are sent out to the clubhouse of a motorcycle club where there are frequent fights. One victim is said to have been injured on his right leg with a metal rod. It is a weekday around 11pm. Law enforcement are also alerted.

Situation on scene

Police are present in large numbers. The scene has been declared safe. There is one victim with an obvious deformity of the right upper leg. He has blood on his pants. The patient is a 34-year-old man. After he was hit on the leg, the fight ended. The victim is sitting against a wall and complains of leg pain.

Primary survey

A: Patent.
B: Normal speech, bilateral breathing sounds, RR 20/min, SpO_2 95%.
C: Rapid pulse which is well beaten and regular, HR 130/min, BP 93/62 mmHg.
D: Awake, GCS 15/15, blood glucose 114 mg/dL, no sensory deficit in the extremities.
E: Open fracture of the right femur.

Would you apply a cervical collar in this scenario?

o Yes
o No

Q10.2 Which element from this scenario made you decide to apply a cervical collar?

o Painful open fracture of the right femur.
o Age of the patient (34-years-old).
o Fighting.
o Based on the clinical neurological examination.
o The use of a metal rod as a weapon.

Q11 In what role are you active in prehospital care?

o Emergency medical technician (EMT)
o Nurse
o Nurse with the special professional title of intensive and emergency care
o Resident in Emergency Medicine
o Emergency Physician
o Anesthesiologist
o Other: _____

Q12 In which region are you mainly working in prehospital care?

o Antwerp (Antwerpen)
o Brussels (Brussel)
o Hainaut (Henegouwen)
o Limburg
o Liege (Luik)
o Luxembourg (Luxemburg, province)
o Namur (Namen)
o East Flanders (Oost-Vlaanderen
o Flemish Brabant (Vlaams-Brabant)
o Walloon Brabant (Waals Brabant)
o West Flanders (West-Vlaanderen)
o Other: _____

Q13 How many years have you been active in prehospital care?

_____

Q14 What is your age?

_____

Q15.1 Do you use a protocol for cervical spine immobilization?

o Yes
o No

Q15.2 Which protocol do you use for cervical spine immobilization?

o NEXUS
o Canadian C-Spine Rule (CCR)
o Prehospital Trauma Life Support (PHTLS)
o Other: _____