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The safety of nurse clearance of the cervical spine using the National Emergency X-radiography Utilization Study low-risk criteria

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Abstract

Objectives: To determine the level of agreement between trained ED nursing staff and senior ED medical staff in the application and interpretation of the National Emergency X-radiography Utilization Study (NEXUS) low-risk criteria (NLC).

Methods: A NEXUS training and accreditation package was developed. It was successfully undertaken by 22 senior ED nursing staff and 26 senior ED medical staff. A study nurse and doctor independently applied the NLC to a convenience sample of patients who had been placed in a hard cervical collar prior to arrival in the ED. The findings for each of the NLC and the overall decision regarding collar removal were recorded on specific case report forms. The primary endpoint was the level of agreement for the overall decision to leave the collar in place. Levels of agreement for the individual NLC were also examined.

Results: In total, 183 patients were recruited. The level of 'safe agreement' where nursing and medical staff agreed that the collar should be left in place was 94.3% (95% CI: 89.5–97.2%). Agreement with regard to individual NLC varied from good to fair. The median times from patient arrival to completion of study nurse and doctor assessments were 14 min (interquartile ranges [IQR] 5–30) and 29 min (IQR 15–47), respectively.

Conclusion: The study demonstrated a high level of agreement between nursing and medical staff for stable low-risk trauma patients.

Key words: *cervical vertebrae, clinical pathways, emergency medicine, emergency nursing, reliability*.

Background

In Australia it is routine that ambulance officers use hard collars to immobilize the cervical spine in people with signs or symptoms of injury above the shoulders, or who have suffered a high-risk mechanism of injury, in order to transport them to hospital ED. The National Emergency X-radiography Utilization Study (NEXUS) group[1] and the Canadian C-spine rule study[2] found that at least 35% of such patients can have their cervical

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spines cleared without the need for cervical spine imaging by using physical assessment and defined clinical criteria.

Reducing the time spent immobilized in hard cervical collars in the ED would be a benefit for patients. The waiting time for medical assessment in minor trauma can be lengthy and is known to be influenced by multiple factors.[3] Volunteer studies have found that hard cervical collars are extremely uncomfortable.[4,5] When worn for as little as 60 min, they might cause neck pain which can persist for over 24 h.[5] At our institution, the mean waiting time for stable, non-urgent patients was approximately 54 min in 2004.

If the cervical spine assessment could be performed by the admitting ED nurse, many collars could potentially be removed much earlier. At some hospitals nursing staff attending minor trauma patients might insert intravenous lines, initiate pathology requests and order imaging for isolated limb injury,[6,7] so pursuing removal of cervical collars following an assessment of the cervical spine seems logical. In order to perform this task, ED nurses would need to demonstrate a satisfactory level of agreement with ED medical staff in their application and interpretation of defined clinical criteria. The level of agreement which might be deemed 'safe', however, is debatable and is likely to be influenced by the expected rate of cervical spine injury in the population under consideration.

There is few published data on the level of interobserver agreement between ED medical staff or between ED medical and nursing staff for either the NEXUS low-risk criteria (NLC) or the Canadian C-spine rules. Reported kappa values ranging between 0.47 and 0.73 suggest only reasonable levels of agreement at best but variations in study design and patient inclusion criteria make it difficult to interpret and compare results.[8–12]

We determined to develop and deliver an education and accreditation programme based on the NLC in order to assess the level of agreement between an equally trained group of ED nursing and medical staff in their assessment of a defined group of blunt trauma patients at low risk for cervical spine injury. Such information would help inform the debate on the potential safety of ED nursing staff performing an initial cervical spine assessment.

Methods

A prospective cohort study on a convenience sample of patients was conducted at Dandenong Hospital from 1 February 2005 to 30 June 2005. Dandenong Hospital is a 430-bed metropolitan teaching hospital. The ED has an annual census of approximately 45 000 adult and paediatric patients. The conduct of the study was approved by the Southern Health Human Research and Ethics Committee.

The investigators developed a training and accreditation package which was successfully undertaken by 22 senior nurse and 26 senior doctor volunteers. The package comprised pre-reading, an interactive group tutorial and a written examination. As there are no precise definitions for the individual NLC, we used standard published guidelines in our educational material.[13] Satisfactory application and interpretation of the NLC on an ED patient, supervised by one of the investigators, had to be demonstrated. The number of staff who participated enabled study personnel to be present on almost all shifts during the study period.

Emergency department patients of any age who had been placed in a hard cervical collar by ambulance officers prior to their arrival in the ED were eligible for inclusion. Patients were excluded if their vital signs or mechanism of injury met the defined criteria for initiating the hospital trauma team response, or if they were unwilling or unable to provide informed consent following study explanation.

A study nurse and study doctor attended eligible patients as early as possible and independently performed a cervical spine assessment. Each recorded the time at which they completed their assessment, their findings for the individual NLC and their decision with regard to collar removal. Patient age, gender, mechanism of trauma, day and time of arrival and language preference were also recorded. The nurse and doctor independently placed their case report forms in a secure box. The investigators later added the patient disposal details and the radiology report if imaging was performed. One calendar month after patient enrolment the investigators checked the hospital attendance register in order to determine if any patient had re-presented with a cervical spine problem.

Data were also collected on all the eligible patients who were not recruited. This included the same baseline information as for the study patients, the time at which the attending doctor performed the cervical spine assessment, the finding for each of the NLC and the necessity for cervical spine imaging.

The level of 'safe agreement' was considered the primary endpoint. This was defined as agreement between nursing and medical staff on the decision to leave the cervical collar in place. Secondary endpoints

were the decision regarding each of the individual NLC, the time to the completion of each assessment and the final diagnosis with regard to either detected or missed cervical spine injury.

The statistical analysis of the primary endpoint involved standard two-way contingency table analysis. The point estimate for sensitivity ('safe agreement') for the performance of the nursing staff in comparison with the medical staff is reported with accompanying binomial exact 95% confidence interval. The study was powered to detect a level of 'safe agreement' no less than 90% (with 95% CI ± 5%). We believed that safe agreement would have to exceed this minimum level in order for nursing assessment of the cervical spine to be considered further. On the assumption that about 40% of eligible patients would have their cervical spines clinically cleared, a sample of 180 patients was needed to detect this required baseline level of safe agreement with its defined level of precision. Two-way contingency table analyses were also to be performed for each of the NLC.

Baseline data involving continuous variables are reported as means with standard deviations and were compared using two-sample *t*-test with two-tailed *P*-value or Mann–Whitney *U*-test where appropriate. Data involving categorical variables are reported as proportions and were compared using chi-squared tests where appropriate.

Results

During the study period 205 eligible patients presented, of whom 183 (89.3%) were recruited. These patients were examined by 114 different nurse-doctor combinations with no same nurse-doctor pair examining more than 10 patients. The most common reason for non-recruitment was that a study nurse was not available. The characteristics of the study population are shown in Table 1. There were no significant differences between the baseline characteristics of those recruited and those not.

The nursing and medical decisions regarding collar removal are shown in Table 2. 'Safe agreement', as defined above, occurred in 99 of 105 patients or 94.3% (95% CI: 89.5–97.2). There were 26 'safe disagreements' where the nurse did not clear the cervical spine but the doctor did. In 25 (96.2%) of these cases, the disagreement involved the presence of either posterior midline tenderness ($n = 13$) or distracting painful injury ($n = 12$). In the six cases of 'unsafe disagreement' where the study nurse cleared the cervical spine but the study doctor did not, the study doctor reported midline tenderness in three and abnormal neurology in three. Two of these patients had their cervical spines cleared without imaging by the subsequently treating ED doctor. The other four had normal imaging.

Table 1. Characteristics of the study population

	Eligible patients recruited ($n = 183$)
Mean age (SD) (years)	34.6 (20.1)
Male gender, n (%)	88 (48.1%)
From NESB, n (%)	22 (12.0%)
Presented in-hours, n (%)	69 (37.7%)
Injured in MVC, n (%)	125 (68.3%)
Admitted to hospital, n (%)	24 (13.1%)

MVC, Motor Vehicle Crash; NESB, non-English-speaking background.

Table 2. Decision making of study nurses compared with study doctors

	Doctor decision, *n* (%)		Totals, *n* (%)
	Collar on	Collar off	
Nurse decision			
Collar on	99 (54.0)	26 (14.2)	125 (68.2)
Collar off	6 (3.3)	52 (28.4)	58 (31.7)
Totals	105 (57.4)	78 (42.6)	183

When comparing the 151 cases with nurse-doctor agreement and the 32 cases with disagreement, the only statistically significant difference was that disagreement was more likely in patients from a non-English-speaking background. Of the nine cases where this occurred, eight (88.9%) involved 'safe disagreement'.

Posterior midline tenderness and painful distracting injury were the most commonly detected of the NLC, being present in about 40% and 20% of patients, respectively. The sensitivities and kappa scores for the individual NLC varied widely from 61.5% to 92.4% and 0.48–0.75, respectively (Table 3).

The median times with their interquartile ranges (IQR) from patient arrival to completion of study nurse and doctor assessments were 14 min (IQR 5–30) and 29 min (IQR 15–47), respectively. The time between assessments exceeded 30 min for 21 (11.5%) patients and 60 min for six (3.3%) patients. The median time to the completion of assessment by an ED doctor for the non-recruited patients was 67 min (IQR 47–82).

No study patients had a cervical spine injury diagnosed or re-presented to the ED within the following

Table 3. Nurse-doctor agreement on the presence of a criterion, overall agreement and inter-rater reliability for the individual NLC

Criterion	Agreement for presence of finding (95% CI)	Overall agreement (presence and absence) (95% CI)	Kappa (95% CI)
Posterior midline tenderness	92.4% (85.2–96.6)	85.2% (80–88.2)	0.70 (0.59–0.76)
Intoxication	75.0% (56.3–85.7)	96.2% (92.9–98.1)	0.75 (0.54–0.88)
Altered alertness	61.5% (39.2–78.3)	94.5% (91.4–96.9)	0.59 (0.35–0.77)
Abnormal neurology	82.4% (63.3–93.1)	95.1% (91.6–97.1)	0.73 (0.54–0.84)
Distracting injury	62.9% (49.1–74.5)	83.1% (77.8–87.5)	0.48 (0.32–0.62)

NLC, NEXUS low-risk criteria.

month with a related complaint. Hence, there were no findings with regard to detected or missed cervical spine injuries.

Discussion

We found that following successful completion of an education and accreditation programme, a group of senior ED nursing staff achieved a high level of 'safe agreement' with a group of senior ED medical staff in the application and interpretation of the NLC in a group of stable low-risk trauma patients who had been placed in a cervical collar prior to arrival in the ED. Given that study nurse assessments could be carried out earlier than routine medical assessments in non-recruited patients, it appears likely that nurse assessment of the cervical spine would reduce the time spent in collars.

Our decision to use the NLC rather than the Canadian C-spine rules was based on reported difficulties achieving full application of these rules, particularly the assessment of neck rotation.[8,10] It has been suggested that the Canadian C-spine rules might have superior sensitivity and specificity for cervical spine injury than the NLC[10] but both are extremely sensitive and the incidence of significant injury is low.[1,2]

The use of 'safe agreement' as we defined it has not been used in previous similar studies. We believe that 'safety' equates with nurse-doctor agreement on the decision to leave the collar in place since the main potentially 'unsafe' situation is where the nurse believes that the collar can be removed but the doctor does not. We based our sample size for the present study on a minimum 'safe agreement' level of 90% because the literature suggests that 'safe agreement' between medical staff is probably no higher than this.[10,11]

It was possible to calculate the level of 'safe agreement' from two of the three studies which have examined nurse-doctor agreement. Hsieh *et al.* in 1998 used a precursor of the NLC and found 'safe agreement' to be 91.1% (95% CI: 86.4–94.5).[9] Pitt *et al.* in 2006 obtained 'safe agreement' of 88.3% (95% CI: 78.3–94.8) and concluded that the nurse assessment of the cervical spine was safe because no cervical spine injuries were missed.[12] The lower results obtained by Hsieh and Pitt might be partly explained by the fact that the education package they used was only delivered to nursing staff and might have been less rigorous than the one employed in our study.

A major difficulty in comparing results between studies and determining a satisfactory level of 'safe agreement' is the variation in the patient populations studied and the likelihood of cervical spine injury being present. Some studies enrolled convenience samples excluding children,[8,9,11] others included children[1,12] and some included only 'stable' patients.[8,10,12] The cervical spine injury rates ranged from 9.5 per 1000 patients (Hsieh[9]) to 24.0 per 1000 patients (NEXUS group[1]). We included children but did exclude all unstable patients as well as those who might have been stable but met other criteria for a trauma team response. The incidence of cervical spine injury in such a subgroup is uncertain, but is likely to be minimal in comparison with the rates reported in most of the other studies. We did not happen to detect any cervical spine injuries in our 183 patients. Given our 'unsafe disagreement' rate of 3.3% and stable trauma load of about 1000 patients every 2 years, the likelihood of an 'unsafe disagreement' coinciding with a rare cervical spine injury seems remote. Of the studies involving nursing staff, Hsieh reasonably raised the concern that their 'unsafe disagreement' rate of 5% might be too high given their burden of injury,[9] but Pitt, with an injury rate of 17.9 per 1000 patients and an 'unsafe disagreement' rate of 6.3% did not raise the issue.[12]

We found that agreement on the individual NLC ranged from fair to good. These results are consistent with those reported in other studies, where presence of

intoxication generally has the best level of agreement and distracting injury the lowest.[4,11] Disagreements on individual criteria are not clinically important if the final decision regarding collar removal is the same, but knowing these figures is important for guiding ongoing education and skills maintenance. For example, with our staff group, the main focus for further attention would be the assessment of posterior midline tenderness, along with the difficulties of assessing patients from non-English-speaking backgrounds.

The study does have a number of potential limitations. There is inherent performance bias with the NLC because most of the criteria are subjective. While their interpretation will vary between staff this should lead to random rather than systematic error. We had been concerned that interpretation of some criteria might be influenced by the length of time between the nursing and medical assessments, but this delay was less than 30 min in the majority of patients.

Potential measurement bias is also relevant. The importance of the study nurse and doctor remaining unaware of the other's findings was understood by all staff, but maintenance of full blinding can not be guaranteed. Bias would almost certainly result in an overestimation of the level of agreement, a difficulty which was also acknowledged by Hsieh.[9] With regard to missed injury, we can also not guarantee that patients did not seek care elsewhere, but our ED registration system includes patients who attend the nearby tertiary referral centre, so we do not believe this is a significant issue.

In conclusion, we found that a group of trained ED nursing staff attained a high level of 'safe agreement' with a similarly trained group of ED medical staff in the application and interpretation of the NLC in a defined group of trauma patients. Nurse assessment of the cervical spine would almost certainly result in a significant reduction in the amount of time spent in cervical collars but it must be noted that our study only included a relatively small number of patients who were at very low risk for cervical spine injury. Large multi-centre research is needed before acceptably safe levels of nurse-doctor agreement can be better defined for different trauma populations. The level of performance monitoring and ongoing education which would be needed for skill maintenance also requires further study. The present study does not address the potential for nurse initiated ordering of cervical spine imaging which we would not support at this stage because of both the moderate number of 'false positives' and the fact that patients might also require other imaging. This could only be investigated further once systems for nurse assessment of the cervical spine were successfully in place.

Competing interests

None declared.

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