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Title:

Investigation into how the threshold to apply the spinal immobilisation algorithm to adult trauma patients is reached by front-line ambulance clinicians in London Ambulance Service

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Abstract

Background:

Selective criteria have been validated both in hospital and pre-hospital environments to safely reduce the number of traumatically injured patients requiring full spinal immobilisation and imaging. The criteria improve the sensitivity in selecting patients with spinal injuries but there is a sparsity of evidence on their application by UK ambulance clinicians

Aims: To identify the knowledge levels and utilisation of the spinal immobilisation algorithm by ambulance clinicians.

Methods: Quantitative survey that utilised a convenience sample of all front-line clinicians in London Ambulance Service NHS Trust

Findings: The algorithm is not routinely used when assessing traumatically injured patients at risk of spinal injury; there is poor recognition of the algorithm inclusion criteria,

specifically patients under the influence of drugs or alcohol, and a belief that too many patients are immobilised unnecessarily.

Conclusion: Further research required on how ambulance clinicians use checklists and a review of paramedic education on spinal immobilisation rules is required.

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Conflict of interest statement

No conflicts of interest to declare.

Background

In the UK there are approximately 1200 spinal injuries per year (McDaid *et al*., 2019). The majority are caused by road traffic collisions, falls from height or violence (World Health Organization, 2013). Of these injuries, about 50% occur in the cervical spine, 37% in the thoracic spine and 11% in the lumbar spine. Damage to the spinal cord can cause a temporary or permanent loss of function that is either complete or incomplete depending upon the extent of cord injury (Diaz, 2019). Spinal cord injury often results in the loss or impairment of motor and/or sensory function, as well as autonomic function, bladder and bowel control (British Orthopaedic Association, 2022).

Prevention of movement of an unstable spine causing secondary injury to the spinal cord led to the process of immobilising all suspected spinal injuries in the 1960's (Ellis *et al*., 2014). The practise became widespread across Europe and North America with Advanced Trauma Life Support guidelines established as the gold standard of care (American College of Surgeons, 2009). Spinal immobilisation involves maintaining the person in a neutral alignment while positioning them on an orthopaedic scoop stretcher, maintaining the head and neck alignment manually until a semi rigid collar is applied and then using head blocks to restrict movement. The patient is then secured to the stretcher with straps. (Joint Royal Colleges Ambulance Liaison Committee., & Association of Ambulance Chief Executives, 2019).

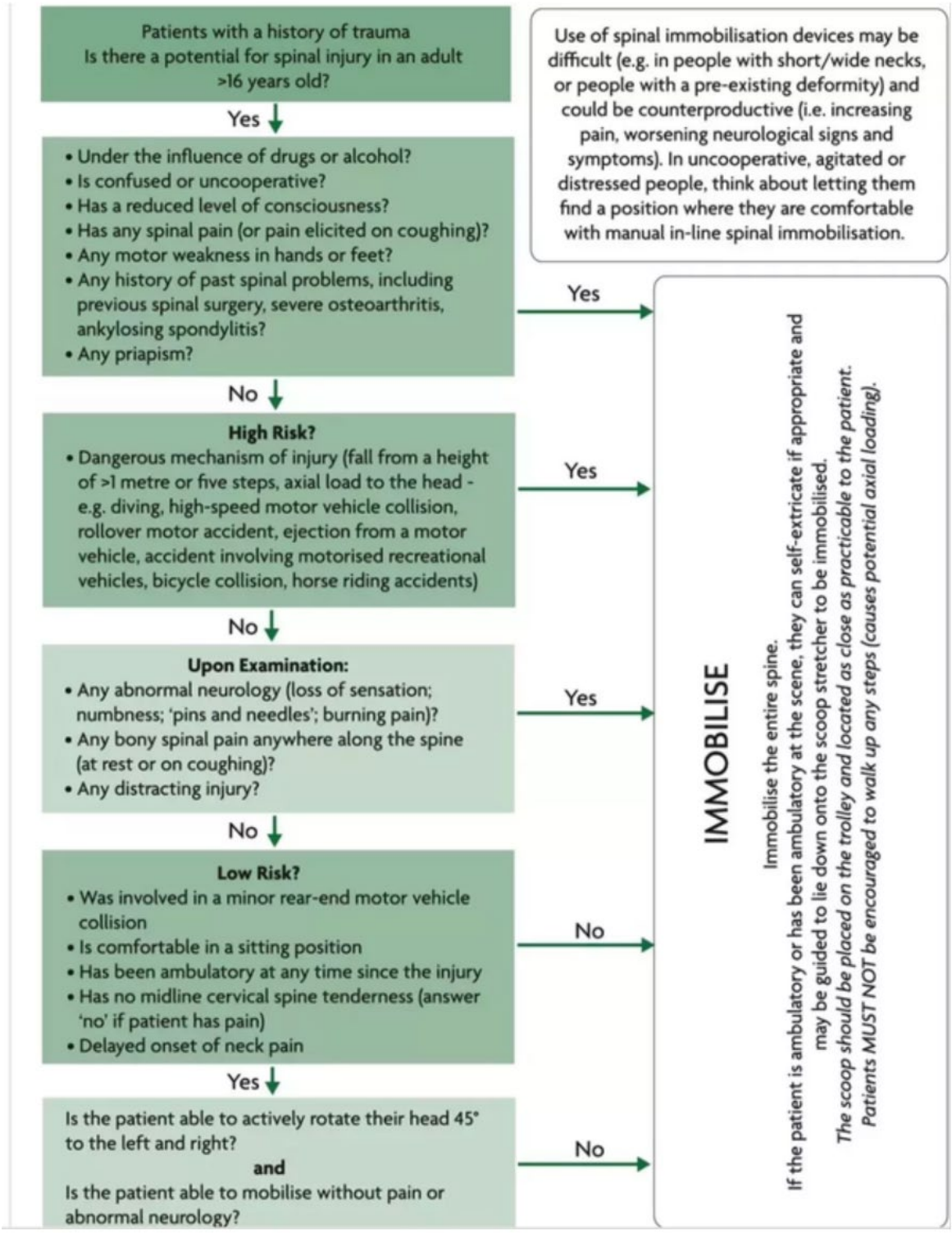
The efficacy of semi-rigid collars has been questioned by Clemency *et al*. (2021) and Hawkridge *et al.*'s (2020) systematic review found that most studies disagreed with spinal collars prehospital. Oosterwold *et al*. (2017) identified potential issues with immobilisation as nausea/vomiting, pain, shortness of breath and combativeness/anxiety. Häske *et al*. (2022) found that the practise of lying on an orthopaedic scoop stretcher for prolonged periods of time can cause pressure ulcers, pain and restrictions of ventilation, leading them to recommend Spinal Motion Restriction as sufficient to prevent unsafe movement when transporting patients. Cowley *et al*. (2022) identify that some groups are more prone to issues with scoop stretchers (bariatric, agitated, older and paediatric

patients and those with spinal abnormalities) and recommend a clearer assessment of risk before transporting. Häske *et al*. (2022) and Cowley *et al*. (2022) identify a need for further training in any tools and protocols to develop greater consistency in practice. Oosterwold *et al*. (2017) demonstrated that paramedics will problem solve at the scene and may improvise in practice.

Algorithms and checklists have been developed to identify those patients most likely to have a spinal injury, thereby avoiding low risk or non-spinal injuries being immobilised. The Canadian C-Spine Rule (Stiell, *et al*., 2001) is utilised in the National Institute for Health and Care Excellence (NICE) (2016) guideline for Spinal injury: assessment and initial management. NICE do recognise potential difficulties in applying this checklist to children as the child's developmental stage should be considered. The algorithm used by UK paramedics is based on the NICE guidelines and Canadian C-Spine rules (Figure 1).

This study explored how paramedics implemented protocols and some of the factors that influenced their decisions in practice.

Figure 1: JRCALC Spinal Immobilisation Algorithm`



Joint Royal Colleges Ambulance Liaison Committee., & Association of Ambulance Chief Executives, 2019. Spinal Injury and Spinal Cord Injury. In: *JRCALC Clinical Guidelines 2019.* JRCALC clinical practice (Version 1.2.5) [Mobile application software ed. Bridgewater: Class Professional Publishing., p. Section 4.

Methodology

This research was conducted as part of the MSc Advanced Practice (Pre-Hospital Care) at the University of Greenwich. It was a quantitative survey that utilised a convenience sample by approaching every eligible frontline clinician within the London Ambulance Service NHS Trust (Table 1.)

Table 1 Inclusion & exclusion criteria

Inclusion criteria	Exclusion Criteria
All patient facing roles: • Paramedics Newly qualified Advanced Clinical Team Manager Clinical Tutors • TEAC2 and EAC • EMT3 and EMT4	• Non-patient facing clinicians e.g., telephone clinicians. • University students on placement

Ethical approval was gained from both the University of Greenwich and the London Ambulance Service NHS Trust. The survey questions were developed by using clinical experience, peer group and evidence-based review of the immobilisation algorithm (Appendix A). The survey questions were written into the online survey platform Qualtrics©. The platform also checked the proposed questions for flow and ambiguity (Qualtrics© , 2020). A pilot study using three of the researcher's colleagues was implemented to ensure access and clarity. The survey was then published on the Trust intranet and was open from 9th March to 4th April 2020 but there were no responses after the 22nd March, which was related to the COVID-19 pandemic. There were 4,096 eligible clinicians and 392 responses were received. The dataset was cleaned to remove entries with incomplete demographic data (n=38) resulting in a sample n=354.

Data Analysis:

Univariate analysis was used to investigate whether there was any difference in the study variables to see if there were any differences between paramedic and other staff. In order to investigate the

association between frequency of use of algorithm and the other study variables a dichotomous variable was created dividing the responses into frequent v infrequent users of the JRCALC algorithm. To analyse knowledge levels relating to indicators of full spinal mobilisation a score was derived based on correct and incorrect responses.

Age and length of service were chosen as the variables of interest following the findings of Considine *et al*. (2007). These authors identified that knowledge and experience, age and length of service influence the triage decision-making process.

Numerical/Ordinal variables were tested by either Independent Sample t tests or Mann Whitney U tests dependent on the distribution of the data. Categorical variables were analysed by cross tabulation which produced a Chi-Square statistic. The cut point by which to reject the null hypothesis was $p \leq 0.05$.

Results

Three hundred and fifty-four paramedic and non-paramedic clinical staff were recruited. The statistics for age and length of service with London Ambulance Service NHS Trust were as follows- Age (37.9, 10.8, Mean, SD), Length of Service (9.3, 8.2 Mean, SD).

The type of jobs reported by the participants were subdivided into Advanced Paramedics (n=22, 6.2%), Paramedics (n=183, 51.6%), Paramedic Team Leaders (n=32, 9%), Clinical Tutors (n=16, 4.5%), Non-Paramedic Clinicians (n=97, 27.4%) and Management Roles (n= 16, 4.5%). These were then subdivided into two groups – Paramedics (n=247, 69.7%) and Non – Paramedics (n=107, 30.3%).

A number of analyses were performed to see if there was any difference between those who were paramedics and other staff. There was not a significant relationship relating to age ($p > 0.3$) but they were more likely to have been employed longer (years) (n=247) (10.1, 8.1, Mean SD) (n=107) (7.8, 8.3, Mean, SD) (Paramedic: Non-Paramedic) (Two-tailed Mann Whitney U test) ($U=27.2$, $p < 0.001$).

Frequency of Use of the JRCALC algorithm

Three hundred and forty-four responded to the question concerning frequency of use of the JRCALC algorithm. The responses were converted into a 5-point scale as follows (Always = 1; Never =5) and produced the following statistics: (2.65, 3.00, 1.17, 1-5; Mean, Median, SD, Range).

For ease of analysis they were subdivided into 'more likely' (always, most of the time and never) n=261 and 'less likely' (hardly ever, never) n=83 (table 2).

Table 2 Frequency of Response

Use of the algorithm	**Frequency**	**Percentage**
1,2,3 (Always, Most of the time, Occasionally)	261	76%
4,5 (Hardly ever, Never)	83	24%
Total	**N=344**	

There was not a significant association with either age (p=0.178) or length of time with LAS (p=0.951), paramedic status (p=0.710) and frequency of use and the JRCALC algorithm. However, those who believed too many people were immobilised unnecessarily (UN) had higher frequency of use of the algorithm scores. (Two-tailed Independent Sample t tests) (n=191) (2.80, 1.15, Mean, SD) (n=123) (2.52, 1.17, Mean, SD) (UN: NUN (not immobilised unnecessarily) (t= 2.03, p=0.043)

<u>Under the Influence of Alcohol and Drugs:</u>

Length of time in LAS was not significantly related to this variable (p=0.342) but older participants were more likely to correctly endorse this item. (Two-tailed Independent Sample t test) (n=104) (40.2, 12.7, Mean, SD) (n=220) (37.4, 9.9, Mean, SD) (Yes: No) (t=2.17, p=0.031).

Less frequent use of the JRCALC algorithm was associated with not endorsing being under the influence of alcohol and drug as an indicator of full spinal mobilisation at a borderline significant level (Two-tailed Independent Sample t test) (n=219) (2.78, 1.11, Mean, SD) (n=103) (2.50, 1.25, Mean, SD). (Less Frequent: Frequent) (t= (-) 1.93, p=0.054). Higher knowledge scores relating to indicators of full spinal mobilisation were associated with endorsing this item (Two-tailed Independent Sample t test) (n=104) (5.59, 0.95, Mean, SD) (n=221) (4.21, 1.19, Mean, SD) (t= 11.2, p

< 0.001). Finally, individuals who did not endorse being under the influence of drugs or alcohol were less likely to believe that too many people were being immobilised unnecessarily (Two-tailed Chi-Square Tests) (n=187) (n=49, 26.2%, n=138, 73.7%, Yes, No) (n=121) (n=46, 38.0%, n=75, 62%, Yes, No) (Chi-Square = 4.80, p=0.028).

Knowledge of Indicators of Full Spinal Mobilisation.

On this occasion (n=325,91.8%) completed the data, there was missing data from 29 participants. The results are shown in Table 3. All the participants endorsed spinal pain, and in these were the other correct responses in descending order, tingling or numbness in the extremities, reduced GCS, history of spinal condition or spinal surgery, weakness in any hand or foot, pelvic injury and finally under the influence of alcohol or drugs. There was one item in the question that does not appear in the algorithm namely penetrating injury to the head, which was endorsed by nearly three quarters of the sample.

These responses were then converted into a knowledge score. All items that were endorsed other than e) were scored as a "1" and item e) was scored minus one. The following are the knowledge scores (n=325) (4.65, 5.00, 1.29, 1-8; Mean, Median, SD, Range)

There was a very weak and non-significant relationship between knowledge scores and age (r=0.08, p=0.181). Staff who were not paramedics had higher scores than paramedics (Two tailed Independent Sample t test) (n=225) (4.5, 1.3, Mean SD) (n=97) (4.89, 1.2, Mean, SD) (Paramedic: Non-Paramedic) (t= (-) 2.18, p=0.030). In contrast those who felt there was not too much unnecessary immobilisation had higher knowledge scores (Two-tailed Independent Sample t test) (n=121) (4.84, 1.25, Mean, SD) (n=187) (4.54, 1.29, Mean, SD) (NIN: IN) (t = (-) 2.03, p=0.043). Finally, higher knowledge scores were associated more frequent use of the JRCALC algorithm. (Two-tailed Independent Sample t test) (n=150) (4.83, 1.22, Mean, SD) (n=172) (4.51, 1.33, Mean, SD) (Frequent: Infrequent) (t=2.23, p =0.026).

Table 3: Indicators of Full Spinal Mobilisation. (n=325) Positive Responses:

	Number	Percentage
a) Reduced GCS	264	81.2
b) Spinal Pain	325	100.0
c) Tingling or Numbness in Extremities	311	95.6
d) Under the influence of alcohol or drugs	104	32.0
e) Penetrating injury to the head	235	72.3
f) Weakness in any hand or foot	218	67.0
g) History of any spinal condition or spinal surgery	219	67.3
h) Pelvic Injury	217	66.7

Are too many patients immobilised unnecessarily.

Three hundred and fifteen (88.9%) participants replied to the question whether they believed too many people were immobilised unnecessarily. Over sixty percent (n=191, 60.6%) thought this was the case and (n=123, 39.4%) replied no. There was not a significant relationship between this belief and age (p=0.950) or length of time in employment of the LAS (p=0.199). Paramedics were more likely to believe too many people were immobilised unnecessarily, the following were the % of positive responses: (Two tailed Chi-Squared Test) (n= 223) (n=153, 68.6%), (n=91) (n=38, 41.7%) (Chi-square= 19.5, $p < 0.001$).

Further knowledge Analysis.

There was a further analysis of two of the variables in Table 3. Firstly, under the influence of alcohol and drugs because it was rarely endorsed correctly indicating a knowledge gap.

Discussion

The key findings of the study were 1) Poor recognition of alcohol and drug intoxication as an indicator for application of full spinal immobilisation. 2) Paramedics scored lower in identifying when to apply immobilisation than non-paramedics. 3) Paramedics were more likely to endorse the opinion that too many patients are immobilised unnecessarily.

Recognition of alcohol and drug intoxication

All respondents recognised that patients who meet the inclusion criteria of the algorithm (over 16 years of age who with a history of trauma and a risk of spinal injury) presenting with spinal pain require full spinal immobilisation, however only a third identified that patients under the influence of drugs or alcohol also require full immobilisation. Older, more experienced respondents were more likely to endorse this correctly. The consensus opinion on validated immobilisation criteria is that patients under the influence of drugs or alcohol cannot have their c-spine cleared in the pre-hospital environment (JRCALC, 2019; NICE, 2016; Vaillancourt *et al*., 2009; Hoffman, 2004). This inclusion is based on the disproportionately high number of spinal injuries in this group of patients (Eldridge *et al*., 2019; Stroud *et al*., 2011; Garrison *et al*., 2004).

There is evidence that ambulance clinicians do sometimes deviate from correct application of the validated criteria, although no explanation is provided as to why this occurs (Kreinest *et al*., 2014; Domeier *et al*., 2005; Vaillancourt *et al*., 2005; Sébastien *et al*., 2001; Stroh & Braude, 2001; Muhr *et al*., 1999). Myers *et al*. (2009) related this non-compliance specifically to pre-hospital assessment of intoxicated patients, although Vaillancourt *et al*. (2005) concluded that ambulance clinicians can apply validated criteria safely. Domeier *et al*. (2005) and Sebastian (2001) considered that paramedics, although risk averse, missed injuries when the criteria were not applied appropriately.

A review of immobilisation criteria by Michaleff *et al*., (2012) recommended improved education to facilitate greater use of the rules with particular attention to subjective components such as intoxication as they are frequently misinterpreted.

<u>Knowledge of the algorithm and full spinal immobilisation</u>

It was expected that education and experience would positively influence the use of the algorithm, but paramedics recorded lower knowledge scores on full spinal immobilisation than non-paramedics. This may be attributed to the different academic pathways of front–line ambulance clinicians that leads to different styles of clinical decision making. University Graduate Paramedics are educated in hyperthetico-deductive reasoning, a structured approach to patient assessment

underpinned by deeper learning whilst non-paramedic clinicians continue to be educated in the intuitive model, utilising a more superficial approach to learning and a reliance on checklists and algorithms for decision making (HCPC, 2021; FutureQuals, 2020; Ryan & Halliwell, 2012). It might, therefore, be expected that non-paramedics would utilise the algorithm more readily than paramedics and produce higher knowledge scores on full spinal immobilisation due to their familiarity with it, but further research is required to determine if this is indeed the case. Remco *et al*'s study (2014) explored the lived experience of paramedics and nurses in applying guidelines, identifying that individual experience, external and organisational environment all influenced paramedic adherence to protocols. A similar study involving UK ambulance clinicians might provide greater insight to the different behaviours identified in this study.

Too many patients are immobilised unnecessarily.

Whilst paramedics demonstrate lower knowledge scores on spinal immobilisation, they were more likely to believe that too many patients are immobilised unnecessarily. It is not clear from the data whether paramedics believed that paramedics apply full spinal immobilisation unnecessarily or that the algorithm captures false positives - further investigation is required to explore the context of these responses. The findings do relate to themes in the literature of disproportionate risk aversion in paramedic decision making, identification of false positives and over-immobilisation when applying validated spinal immobilisation criteria (O'Hara *et al*., 2015; Vaillancourt *et al*., 2014; Domeier *et al*., 2005). A review of the implementation of the Modified Canadian C-spine Rule by paramedics (Vaillancourt *et al*., 2023) concluded that paramedics can safely apply the rules to low-risk trauma patients and reduce the number of patients requiring immobilisation during transport suggesting that if the algorithm is being applied appropriately there would be a reduction in unnecessary immobilisation.

Conclusions

The study has highlighted a knowledge gap which should be considered in the development and delivery of both paramedic and non-paramedic education on the rules of spinal immobilisation. Further research is required to determine why there is poor recognition that traumatically injured patients need to be assessed for intoxication with drugs or alcohol if immobilisation is to be removed and improvements to training in the application of the algorithm.

The belief that too many patients are immobilised also requires further investigation. The recent evidence that paramedics can safely apply rules to low risk trauma patients and reduce the need for immobilisation during transport suggests knowledge of the algorithm or confidence in its use is insufficient and further education on the rules is required.

Limitations of the study

The study was conducted as part of an MSc degree with fixed time and resource limits. The questionnaire was released in late February 2020 and responses dropped off sharply as the COVID-19 pandemic escalated. At the beginning of March, the London Ambulance Service dealt with the unprecedented impact of the virus on its services. The author acknowledges that the sample size was smaller than had been anticipated but the time restrictions of the MSc course precluded extending the data collection period.

Key points

1. Validated criteria in the form of the JRCALC Spinal Immobilisation algorithm have been introduced to pre-hospital care to safely reduce the number of patients that require full spinal immobilisation.
2. There are gaps in paramedic knowledge of the algorithm inclusion criteria, specifically patients under the influence of drugs or alcohol.
3. Paramedic compliance with the algorithm is not consistent or fully understood but may be influenced by personal experience and education.

Reflective questions

1. Reflect on your utilisation of the spinal immobilisation algorithm – does it support your clinical decision making on traumatically injured patients?
2. What other clinical decision-making tools could be used to assess traumatically injured patients?

3. Has the move to reduce the number of patients immobilised been a safe one – if criteria are not applied should there be a return to blanket immobilisation?
4. Should the use of the immobilisation algorithm be mandatory in all trauma presentations?

Key Words

Spinal, immobilisation, algorithm, alcohol, drugs

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Appendix A

Survey Questions

1	I have read the attached participant information sheet and consent to the survey	
2	How many years have you worked for the London Ambulance Service Trust?	
3	What is your age?	
4	What is your job title?	
5	What is your pay band level?	
6	Do you use the JRCALC spinal immobilisation algorithm for traumatically injured adults?	Always Most of the time Occasionally Hardly ever Never
7	Full spinal immobilisation includes application of the following devices:	Head blocks Cervical Collar Traction Splint Orthopaedic Scoop Stretcher
8	The following features in a traumatically injured adult patient would indicate the need for full spinal immobilisation *(select all that apply)*	Reduced GCS Spinal Pain Tingling or numbness in the extremities Penetrating injury to the head Weakness in any hand or foot History of any spinal condition or spinal surgery Pelvic injury Other
9	It is possible to clear the cervical spine on the following adult patients *(select all that apply)*	Isolated penetrating injury to the head Intoxicated patients with no mid-line cervical spine tenderness Confused elderly patient who has fallen from standing Low mechanism, no abnormal neurology and ambulatory since the incident Agitated patients with head injuries Patients who have self-extricated Other
10	Too many patients are immobilised unnecessarily	Agree Disagree