

Journal of Forensic and Legal Medicine

Custody Early Warning Scores; do they predict patient deterioration in police custody?

--Manuscript Draft--

Manuscript Number:	JCFM19-507R2
Article Type:	Research paper
Keywords:	Custody; Assessment; Health; Detainee; Warning Scores
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Order of Authors:	Tim Miles, PhD Vanessa Webb, Professor Peter Kevern, Professor Raj Shibchurn Tom Bird George Finch
Abstract:	<p>This paper analyses the results of a three month trial based in a police custody suite, where we assigned a value; using the recently developed Custody Early Warning Score, to detainees arriving into police custody, as part of their 'booking in' process. We then compared this to the more established National Early Warning Scoring system and then looked at the predictive accuracy of these two systems and how they correlated to one another, when applied to three different clinical groups of detainees in police custody. Police Custody Sergeants and Custody Detention Officers continue to experience difficulties in identifying those detainees with health care needs; be they subtle, emerging or more evident. The introduction of a 'track and trigger' physiological scoring system has been seen to reduce morbidity in health care settings and so the adoption of an altered custodial version of such a system is an effort by some police forces to do likewise. Recent innovations in police custody have focussed on identifying and appropriately referring those detainees with mental health needs. There is a lack of research that examines the physical health needs of the custodial population and the risks that they might present. With detainee deaths and serious adverse events continuing to occur in police custody, forces are looking at ways to identify risk early on in the custodial process, to reduce such high profile occurrences. Police use of the Custody Early Warning Score system, is one effort to try and identify and reduce this risk, early on in the custodial process. Objective In an increasing number of police custody suites, the Custody Early Warning Score system has been added to the normal, standardised police risk assessment process. This 'track & trigger' system has been adapted to the custody environment and is conducted by non-medical detention staff upon detainee arrival, in order to identify detainee morbidity and mortality risk. We wanted to test the predictive accuracy of this system at identifying detainee health need and prioritisation. We also wanted to know how well this tool correlated to another well-established monitoring tool and how accurate these two systems are at pre-empting the medical emergencies and hospital referrals that occur in police custody. Results 1'163 detainees were assessed by medical staff over a three month period, with staff blinded to the assigned scoring. 276 of these were identified as requiring further clinical assessment following this scoring with 29 of the 33 patients referred to hospital by medical staff, also scored, with some declining assessment or were serious enough to abandon scoring. Whilst we found a small correlation between increased scores and referral to hospital; we found that there little correlation between assessment scores in general and the need for referral to hospital. We also found that most clinical risk was associated with lower or low scores. Conclusions The scoring systems that we assessed were not sensitive enough to identify health need in the detainee population, due to frequent, altered physiological parameters. Life threatening conditions have low assessment scores, not reflective of the seriousness of medical conditions, nor the potential for rapid deterioration. Such scoring systems add little to</p>

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Cover Letter for Submission

Title of Manuscript

To evaluate the effectiveness and predictive accuracy of the National Early Warning Score and the Custody Early Warning Score in predicting deterioration of patients in police custody.

Contributors Names and Affiliations

Tim Miles. Mountain Healthcare Ltd
Prof. Vanessa Webb. Mountain Healthcare Ltd
Prof. Peter Kevern. Staffordshire University
Raj Shibchurn. Mountain Healthcare Ltd
Tom Bird. Mountain Healthcare Ltd
George Finch. Mountain Healthcare Ltd

Statement- Objective of Research

An abridged health scoring system called *Custody Early Warning Scores* has been introduced into some police custodies to reduce death and mortality. Our data shows that this is an inaccurate and insensitive tool, missing the unwell whilst providing false reassurances, especially when used by untrained detention staff.

Statement- Approach

We analyzed data that was gathered over a 3-month period in police custody. Vital signs were recorded on 1'163 detainees upon arrival and a National Early Warning Score (NEWS) or Custody Early Warning Score (CEWS) was later calculated and assigned. Then we assigned scores to those referred to the in-station clinician and then also those referred to hospital. None of the clinicians knew the end score and were blinded to the outcomes.

We then calculated the accuracy of these two scoring systems and matched this against simple clinical judgment looking at clinical outcomes.

Novel Contributions

1. The well-established National Early Warning Score is not suitable for use within police custody suites as it lacks the sensitivities necessary to identify these uniquely unwell patients
2. The more recently developed Custody Early Warning Score lacks sensitivity and specificity when used as a screening tool in police custody
3. Police custody detainees have unique health problems with altered clinical responses to illness; professional clinical judgment is favored over current track and trigger type assessment tool.

Other Similar Journal or Conference papers

The researcher is not aware of any research to date, or overlap of research, that has tested the use of NEWS and CEWS scoring in the real world setting of police custody suites, especially as CEWS is designed to be used by non-medical detention staff. Other studies have looked at NEWS alone, but only in other clinical and community settings.

Reference to the closest prior article

McKinnon I. Finch T. Contextualizing health screening risk assessments in police custody suites- qualitative evaluation from the HELP-PC study in London, UK.

(BMC Public Health (2018) 18:393. <https://doi.org/10.1186/s12889-018-5271-6>)

Experts in this area not associated with the research

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Ewa Wolska. Mountain Healthcare Ltd. ewa.wolska1@nhs.net

GMOD Editors thought to be most qualified

Peter Lindstrom
Nicholas Patrikalakis

Technical areas and fields of expertise necessary to understand and evaluate this contribution; its potential and novelty

Tool
Application
Health Risk
Custodial Health



PROPORTIONATE REVIEW APPROVAL FEEDBACK

Researcher Name:	Tim Milles
Title of Study:	To evaluate the effectiveness and predictive accuracy of the National Early Warning Scores 2 (NEWS) and the Custody Early Warning Score (CEWS) to predict deteriorating patients in a police custody.
Status of approval:	Approved

Your project proposal has been approved and you may commence the implementation phase of your study. You should do so in conjunction with your supervisor.

You should note that any divergence from the approved procedures and research method will invalidate any insurance and liability cover from the University. You should, therefore, notify the Panel of any significant divergence from this approved proposal.



Signed: Dr Peter Kevern
School ethics coordinator

Date: 29.7.19

List of Changes or Rebuttal

SCIENTIFIC JOURNAL: JOURNAL OF FORENSIC AND LEGAL MEDICINE

SCIENTIFIC PAPER: JCFM19-507

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Score (NEWS) is increasingly being recommended at a national level for use outside such settings (Brangan et al 2018). Clinical deterioration and Serious Adverse Events (SAEs) are often preceded by subtle changes in basic physiological parameters and mental status. Studies have reported that evidence of clinical changes; noted by the altering of those parameters, is often present hours before the occurrence of SAEs, which has led to the development of early warning score tools for the early recognition of patients at risk of deterioration (Brangan et al 2018).

To detect these changes, the National Early Warning Score systems, are used throughout the National Health Service (NHS), as recommended by the Royal College of Physicians Acute Medicine Task Force report; Acute Medical Care; the right person, in the right setting- first time (RCP 2007). This recommended a standardised, easy to use warning system to better identify patients at risk of clinical deterioration; to affect more timely intervention and thus save lives. From this, the National Early Warning Score (NEWS) was launched in 2012.

Risk assessment in police custody is a complex task, requiring patience and an effective screening tool. It is not within the scope of this research to comment on the national risk assessment tool currently used; our aim of this study was to evaluate the effectiveness and predictive accuracy of the National Early Warning Scores (NEWS) and the Custody Early Warning Score (CEWS) as a predictor, to detect deterioration of patients in police custody, which can be a coercive environment making the clinical picture difficult to interpret, with fabricated illnesses, deviant behaviour, social difficulties and boredom increasing health risk, whilst the custodial population is recognised as having greater morbidity than the population average (McKinnon, et al. 2016).

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8. The method needs more explanation. Where and when did you do your research? How many detainees? Who did the scoring? And what is a normal way of handling of the care takers when the detainees are first seen?

Our research was conducted in police custody in Southern England throughout January to March 2019. The normally duty clinician present in custody applied NEWS and CEWS scoring to a total of 1'163 detainees arriving into police custody, recording these parameters. This represented a simple additional step to the usual police custody booking in process, whereby all arriving detainees are asked a series of self-reported health questions by the Custody Sergeant on duty, which represents the custody risk assessment process. The responses are recorded verbatim and any referral to custody medical services depends on these answers and the Custody Sergeants interpretation of them, based on previous knowledge and experience. Traditionally, clinicians who in our research were present on site do not play any meaningful part in this initial health screening.

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Reworded and clarified with the addition of *month one, month two and month three* for clarity

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14. The higher percentage of clinically moderate and higher risk patients in the trial would be expected to generate higher scores, but our evidence shows that this is not so. In these higher risk custodial patients, we predicted the increase in the hospital transfer rate, because of drug, alcohol and lifestyle factors.

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Objective

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Conclusions

The scoring systems that we assessed were not sensitive enough to identify health need in the detainee population, due to frequent, altered physiological parameters. Life threatening conditions have low assessment scores, not reflective of the seriousness of medical conditions, nor the potential for rapid deterioration. Such scoring systems add little to the risk assessment process, with low scores allowing for complacency and a false reassurance, when using a system designed for very different circumstances.

Key Words

Custody; Assessment; Detainee Health; Warning Scores.

Do Custody Early Warning Scores accurately predict deterioration of patients in police custody?

Several assessment tools based on vital signs have been developed for the early screening of patients at risk of clinical deterioration. A recent meta-analysis demonstrated that introducing Early Warning Scores (EWS) did not significantly improve mortality or Serious Adverse Events (Sutherasan, et al. 2018), however, those results may be due to the use of modified forms of the EWS together with different thresholds and methodology, making it difficult to compare between studies, although it is such a modified version of the National Early Warning Score (NEWS) that we examined here.

When used in the hospital setting, which is its original purpose, increased NEWS at admission is associated with earlier death and ICU transfer within 2 days after admission. NEWS also performs better than other scoring systems for assessing medical risk in hospital settings; nevertheless, its impact on patient outcomes has not been investigated. The main purpose for applying a triaging system in custody is earlier detection of patients at risk of deterioration and to provide appropriate custodial management, which is usually straight forward at embedded practitioner custody suites.

Clinical deterioration and Serious Adverse Events (SAEs) are often preceded by subtle changes in basic physiological parameters and mental status. Studies have reported that evidence of clinical changes; noted by the altering of those parameters, is often present hours before the occurrence of SAEs, which has led to the development of EWS tools, for the early recognition of patients at risk of deterioration (Brangan et al 2018), which are now in widespread use.

To detect these changes, the National Early Warning Score systems, are used throughout the National Health Service (NHS), as recommended by the Royal College of Physicians Acute Medicine Task Force report; Acute Medical Care; the right person, in the right setting- first time (RCP 2007). This recommended a standardised, easy to use warning system to better identify patients at risk of clinical deterioration; to affect more timely intervention and thus save lives. From this, NEWS was launched in 2012.

NEWS acts as a simple adjunct to describe the clinical condition of a patient and track physiological changes, with it more recently functioning as a common language between departments and services, easily identifying the more serious patient. This standardised measuring tool can be interpreted consistently, with rising scores indicating the need for intervention. It is used for initial assessment, as well as continuous monitoring, identifying clinical deterioration and providing a trigger for escalation of care. Since its launch, its uptake within the NHS has been extraordinary, with

the majority of NHS acute hospitals now using the system, along with ambulance and primary care (Williams, 2017. NHS England 2018).

In December 2017, an updated version of NEWS was published; NEWS 2. This resulted in improved vital sign recording of as well as recognising the importance of new onset confusion and the reinforcement of the value of aggregate scores versus single parameter recordings. Like NEWS before it, it is based on a simple aggregate scoring system in which a score is allocated to physiological measurements. NEWS 2 comprises a simple calculation method, based on the physiological parameters of respiratory rate, pulse rate, systolic blood pressure, oxygen saturation, the presence of oxygen supplementation, and neurological status (RCP 2012). To date, few studies are available describing specific interventions according to this and although there is usefulness in the shared understanding of physiological measures, there is limited evidence of its pre-hospital effectiveness (Pirneskoski, et al. 2017).

The NEWS 2 (commonly known as just NEWS) system is a Care Quality Commission compliance indicator during hospital inspections, as it has been found to be effective and work well, with improved patient outcomes and lives saved (CQC 2018). NHS England, with the support of NHS Improvement have fully endorsed NEWS and have mandated its use to 100% of acute trusts and ambulance settings by March 2019, with all acute hospitals mandated to transition to its use. Its use is encouraged within mental health trusts and its use in the community is undergoing an evidence gathering process (NHS England 2018), although it is emphasised that it should be used alongside other sources of clinical information (Brangan, et al 2018).

In police custody, risk assessment is a complex task, requiring patience and an effective screening tool. In an attempt to address this difficulty, an EWS system has been adopted by some forces for custodial use. Termed; CEWS, the Custody Early Warning Score was originally intended for the regular and repeated monitoring of detainees who had consumed or secreted in bodily cavities; drugs prior to their arrest, which would be an effective use of the tool in helping to detect early signs of drug absorption. CEWS itself is an adapted version of other track & trigger systems, as recommended by the National Institute for Health and Clinical Excellence (Centre for Clinical Practice, 2007) for the early recognition of acutely ill patients, as initially, there may be no symptoms or signs of absorption. In the police custody where we conducted our research, CEWS was being used by non-medical police custody staff as a one-time measurement of health risk, which is a radical departure from its original intention.

Given that CEWS scoring is conducted by non-medical police custody staff, it omits the measurement of blood pressure, as this takes skill and practice; although this is a fundamental physiological finding. With respiratory rate and temperature also omitted, the predictive accuracy of this as a screening tool is questionable, especially for its use as a one-time measurement of health status. The addition of pupil size measurement presents a challenge for even the experienced clinician, with different estimations of size reported, between different types of clinician, and so its measurement by non-clinical staff; and the reasons for any alterations seen, will be a demanding task that will almost inevitably lead to wide variation (Clark, et al 2006).

Methods

Our research was conducted in police custody in Southern England throughout January to March 2019. The normally duty clinicians, present in police custody, applied NEWS and CEWS scoring to a total of 1'163 detainees arriving into police custody, recording these parameters. This represented a simple additional step to the usual police custody booking in process, whereby all arriving detainees are asked a series of self-reported health questions by the Custody Sergeant on duty, which represents the custody risk assessment process. The responses are recorded verbatim and any referral to custody medical services depends on these answers and the Custody Sergeants interpretation of them, based on previous knowledge and experience. Clinicians, who in our research were present on site at all times, do not play any meaningful part in this initial health screening.

Phase-1

For the first month, clinical observations were recorded on all detainees by our clinical staff upon their arrival into police custody or shortly after. Those who declined consent or who were too violent or un-cooperative were not included in the figures or the results and so are excluded, as were those who; upon arrival, were deemed not authorised for police detention due to the nature or circumstances of their arrest. Our clinicians, who were a mix of doctors, nurses and paramedics, did not alter their current practice and therefore continued to use clinical judgement to determine if;

- No further assessment was needed
- A more detailed assessment was required
- A more urgent referral to hospital was warranted

This is simply a continuation of normal assessment practice, albeit with the addition of NEWS and CEWS scoring

Phase-2

The second month of the research saw those identified by the police risk assessment as requiring further intervention had vital signs recorded which were again converted into a NEWS and CEWS score by research staff, using the raw data alone. The outcome options from this were;

- No further assessment required following brief clinician triage
- A more detailed assessment required and any treatment decided by the clinician
- Hospital referral following clinical assessment

This again represents a continuation of normal practice, with the addition of NEWS and CEWS scoring to this cohort.

Phase-3

The final one month phase of our research applied NEWS and CEWS scoring just to clinician initiated hospital referrals which also had the clinical outcomes recorded, as data was obtained from the

company reporting system, which includes all hospital referrals. Through the review of all hospital referrals, the correlation between NEWS and CEWS was calculated.

Results

Over the 3 month research period medical staff assessed 1'163 detainees in total and assigned NEWS and CEWS scores to them. This represents every single person admitted to custody in our research area during this period, who chose to give their consent and were compliant. Of this total number seen;

Phase 1 - 858 detainees which represents every person arriving into police custody over 1 month.

Phase 2 -276 detainees, which represents all those identified during the initial custody sergeant led risk assessment process as requiring further input from custody medical staff, over a 1 month period.

Phase 3 - 29 detainees, which represents all those detainees who having been clinically assessed by medical staff, were then referred to local Accident & Emergency departments as requiring further clinical input.

Summary Graph of NEWS and CEWS assigned police detainees

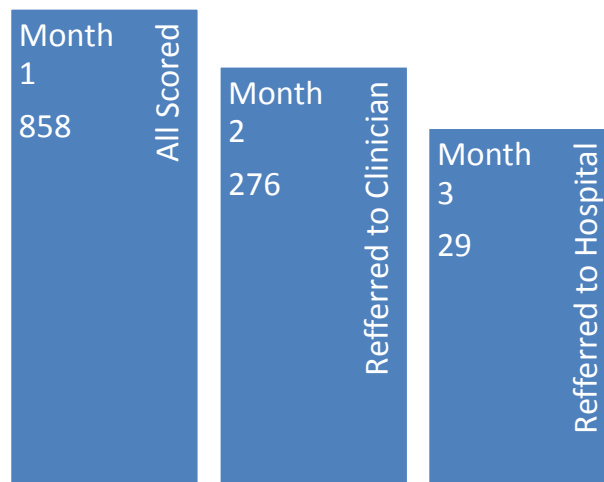


Figure 1

Hospital referral.

Examining CEWS scores alone, we found that the majority of hospital referrals (28%) had a CEWS score of 1 (with the totality of all medical conditions considered) whilst those with a score of zero (22%), being the next cohort of hospital referrals. Those who were referred by the clinician to hospital showed a small correlation of their medical condition with higher NEWS or CEWS scoring of 4 and above, in a small percentage of cases. Higher CEWS scores of 4 or 5, which would imply

notable pathology almost certainly requiring further assessment, constituted 2.7% and 5.5% respectively.

When looking at NEWS scores alone, we found that of the total number of assessments carried out, 58% scored 0, whereby 2.8% scored 3, and a score of 4 was seen in 0.95% of people. However, in the category of patients scoring 1 and 2, we found these correlated to 28% and 11%, of those assessed. Looking at CEWS scores alone, with the same cohort of people; we found that CEWS scores of 48% scoring 1, 4% scoring 3, less than 0.5% scoring 4 and 0.2% scoring 5.

So to assess the predictive accuracy of these systems, we looked at what happened to the higher scoring patients. With NEWS scoring, 30% of those referred to hospital, had a score of 3; which is still a comparatively low score. Approximately 12% had a score of 4 with 6% scoring 6 (there were no scores of 5). When looking at CEWS scoring of the same cohort again, we see approximately 10% of those referred to hospital scoring 3 (which is still a low figure), 5% scoring 5 and 3% scoring 4.

Listed in order of commonality of hospital referral, we see the top-5 reasons for referral of the 276 cases over the study period;

- Head Injury (25-cases. 9.0%), average CEWS score; **4**
- Overdose (24-cases. 8.7%), average CEWS score; **2**
- Diabetic Ketoacidosis (8-cases. 2.9%), average CEWS score; **2**
- Drug concealment (pre-determined swallowing or rectal packing, 22-cases. 7.8%), CEWS **2**
- Chest pain (48-cases. 17.4%), average CEWS score; **1**

This gives the mean CEWS score of the top five referral reasons as **2.2**.

More people have CEWS and NEWS scores of 0 than 1 and more of 1 than 2 and so on, so to give these figures greater generalisability, it is useful to convert the number of detainee admissions with each score to the number of admissions per 1000 people, giving the following data;

CEWS score Admissions per 1000 with this score;

0 15.6

1 34.5

2 63.6

3 100

4 166.7

NEWS score Admissions per 1000 with this score;

0 24.3

1 30.6

2	25.2
3	142.9
4	166.7
5	1000

Referrals to hospital following police risk assessment and staff medical assessment

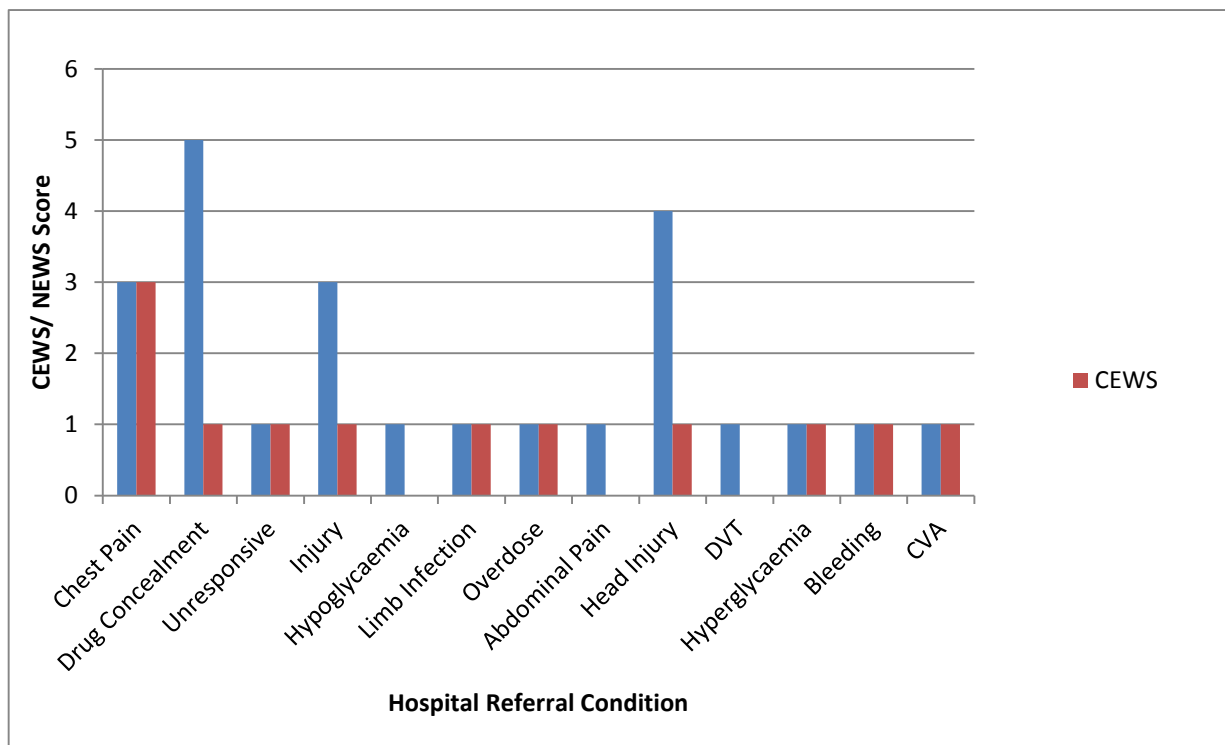


Figure 2

Discussion

This study compared two different types of Early Warning Score systems to triage police custody detainees, which was in addition to the usual practice of the custody sergeants use of the Police and Criminal Evidence Act (Home Office 2017) own risk assessment process to triage patients in police custody. To ensure any bias was minimised, appropriation of scoring was not undertaken by the clinician as all clinicians undertook assessments and there was no effort to stratify to different clinical skill sets. To avoid any confirmation bias, we used practitioners who were normally on duty. Medical staff were aware of the research but only in so much as to provide a consistent approach with reliable data. they were unaware of any results and could not access finished data. Some were familiar with NEWS from previous areas of employment but none had used NEWS or CEWS systems in police custody, therefore we would argue that there was very little confirmation or first impression bias. Three people correlated the data and so we feel confident that any inherent bias should be greatly reduced.

Using either NEWS or CEWS did not change overall patient outcomes in our study. In common with the national custodial population, we expected to see an increased percentage of moderate and high clinical risk patients, due to alcohol and drug consumption along with chaotic, risk-taking lifestyles, so the research would be expected to generate higher NEWS and CEWS scores to reflect this ill health, but our evidence does not support this hypothesis. In these higher risk custodial patients, we predicted an increase in the hospital transfer rate, because of these lifestyle factors and regular use of such substances (Payne-James, et al. 2010, Payne-James, et al. 1997).

There is some degree of correlation between CEWS scoring and a referral to hospital from police custody and this correlation increases slightly when assessing with NEWS scoring alone, however it is very difficult to estimate how much these altered physiological parameters are due to substance and alcohol misuse, as well as underlying acute mental health anxieties. The clinical picture is further complicated when we consider the nature of arrest, which may involve detainee aggression and violence along with the police responses to such acts; including incapacitant sprays and electrical stun weaponry. Even the act of fleeing from police, being pursued and apprehended without any further use of force would still alter scoring parameters for some hours following arrest, whilst swallowing or concealing drug wraps; seen as a major custodial red-flag, would unlikely see scoring changes at all; at least at the point of assessment. This does not make for safer practice.

Higher CEWS at booking in would suggest hospital referral within an hour and so, and so is a useful adjunct predictor in higher scoring patients but not a useful predictor in lower scoring patients, who form the bulk of hospital referrals. However, these higher scores are likely to be late presentations of deteriorating medical conditions. The picture is similar for NEWS scoring and it could be argued that this has a slightly increased sensitivity, given the broader range of lower scoring patients. However, the amounts are still low, with low NEWS scores still forming the bulk of hospital referrals.

The majority of those referred to hospital generally have a NEWS or CEWS score of <2, with the mean of the top 5 reasons being 2.2 which would be expected, given the association of drug and alcohol influenced nature of the custodial detainee. With these results, we sought to discover what percentages of those with a score of 1 were referred to hospital, compared with what percentage of those with score of 4 or more. Of course, there will be fewer patients with a score of 4 or more, so inevitably there will be fewer people in this cohort being referred, but this was not seen as a relevant statistic; it's the difference in the probabilities that tell us the predictive value of NEWS and CEWS.

With the exception of a single outlier for a NEWS score of 2, our results suggests that CEWS and NEWS cannot predict outcomes with any certainty; which is the nature of risk and the essence of the police risk assessment. However, custody sergeants should certainly pay attention to people with scores of 3 or above on either CEWS or NEWS systems, as there is at least a 10% probability they will be referred to hospital before the end of their detention period, notwithstanding the lower scoring patients who form the majority of those referred to hospital.

Even with these figures, it is experienced clinical judgement that determines the urgency of care, so it is strongly suspected that such referrals would have occurred anyway due to clinical judgement of the presenting condition as this 10% cohort were seen by clinicians anyway as a result of the initial police custody risk assessment process and not the scoring, and so a hospital referral was less likely to be dependent on a NEWS or CEWS score. We are reminded that such track and trigger systems

are used to support clinical judgement, not drive it. In the majority of hospital referral cases, detainees were referred on clinical judgement despite a usually lower NEWS or CEWS score, with chest pain, head injury, overdose of substances, drug concealment and diabetic ketoacidosis being the main reason for referral, all of which had lower NEWS and CEWS scores.

We found that higher NEWS or CEWS upon arrival into custody was associated with increased hospital transfer rates, which is in line with recent studies recommending NEWS as a potential triage tool for medical patients, but importantly, implementing the NEWS or CEWS alongside clinical judgement, did not change overall patient outcomes and so it can be argued that where there are embedded medical staff in police custody, CEWS adds little to the clinical picture when used as a decision tool

Also, using CEWS or NEWS in Custody can be falsely reassuring as a lower scoring number as described could be seen as 'safe' by the non-medical staff who are entrusted with assigning the score, whilst missing those of deteriorating health. There must be further work to evaluate these systems and further training required if non-medical police staff are to be entrusted with this responsibility.

To ensure any bias was minimized, appropriation of scoring was not undertaken by the clinician. All clinicians undertook assessments and there was no effort to stratify to different clinical skill sets. To avoid any confirmation bias, we used practitioners who were normally on duty. Medical staff were aware of the research, but only in so much as to provide a consistent approach with reliable data. They were unaware of any early results and could not access finished data. Some were familiar with NEWS from previous areas of employment but none had used NEWS or CEWS systems in police custody. Therefore, we would argue that there was very little confirmation or first impression bias. Three people correlated the data and so we feel confident that any inherent bias should be greatly reduced.

Ethical Consent

Police forces do not have ethics committees and so we sought and were granted permission to conduct our research by the Custody Inspector, who has the necessary authority to permit this. To be able to meaningfully use the generated data alone, we were granted permission by Staffordshire University ethics committee.

Limitations

There were two main limitations in this study. First, we did not control patients in the groups to have the same overall disease severity and prognosis. Consequently, the percentages of moderate and high risk patients were higher in the stage-2 protocol group. Moreover, the ICD-10 diagnoses differed between groups. The fact that the groups were observed over different months, could give concern that there could be seasonality of some symptoms. This work was conducted in a real-world setting in which it was not possible to recruit patient in a randomized fashion. A single-centre randomized control trial should be conducted in which both the control and protocol groups are selected from patients during the same time period and to which patients are randomly assigned. The cluster multicentre randomized control trial may be another solution. Secondly, we did not

analyse the protocol adherence and compliance of the medical staff, which may have also affected the outcome or take into account any previous experience with scoring systems.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors

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Glossary

Detainee- an arrested person brought into police custody for the purposes of criminal investigation.

ICD-10. The International Classification of Diseases, edition-10. ICD is the foundation for the identification of health trends and statistics globally, and the international standard for reporting diseases and health conditions. It is the diagnostic classification standard for all clinical and research purposes. ICD defines the universe of diseases, disorders, injuries and other related health conditions. ICD-11 is now available.

PACE- Police and Criminal Evidence Act (1984, revised 2005), which is the Act under which detainees are arrested and dealt with whilst in custody. This Act sets out certain rights and entitlements whilst detained.

Risk Assessment- seen as the cornerstone of custodial care, this list of largely 'yes/no' type questions is carried out on all arriving detainees, including those re-arrested and prison inmates held over on transfer or for production.

TASAR- an electrically driven compliance weapon, rather like a pistol, delivering a high voltage/ low amp charge to briefly stun an assailant, facilitating police restraint.

Appendix

CEWS scoring consists of the following;

- Oxygen saturations
- Pulse rate
- Alertness to rousing
- Pupil size
- Behaviour

NEWS scoring consists of;

- Oxygen saturations
- Pulse rate
- Respiratory rate
- Temperature
- Use of supplemental oxygen
- Systolic blood pressure
- AVPU

Title page containing contributors

To evaluate the effectiveness and predictive accuracy of the National Early Warning Score and the Custody Early Warning Score in predicting deterioration of patients in police custody.

Abstract

When a person is booked into police custody in the United Kingdom, they undergo a risk assessment, conducted by custody sergeants. With deaths and serious incidents continuing to occur, some forces are looking to add Custody Early Warning Scores, based on the National Early Warning Score. This introduction into police custody is unusual and raises concerns; as this scoring is to be used by non-medical staff to clinically grade arriving detainees, blurring its original purpose.

We felt that this altered scoring system would be insensitive to the specific health problems of detainees, given the frequent uses of alcohol, stimulating and sedating drugs, and sometimes, the forceful nature of the arrest, all resulting in physiological changes making scoring unreliable and insensitive to true health markers.

We were also concerned that a 'good' score would give false reassurances to staff and that there would also be false negative and false positive scores; clouding the health picture.

We also tested the correlation between these different systems; to see if one method was more sensitive than the other and if either was of use in police custody.

Results

1'163 detainees were assessed by medical staff with both scores noted, with 276 of these referred to the on-site medical staff. Twenty nine of the 33 patients referred to hospital, by medical staff were also scored, following medical assessment, with some declining assessment or were serious enough to abandon scoring.

Conclusions

Life threatening conditions have low assessment scores, not reflective of the seriousness of any medical condition, nor the potential for rapid deterioration. Whilst we found a small correlation between increased Custody Early Warning Scores above 4 and referral to hospital; such scores add little to the risk assessment process, with the low scores allowing for complacency and a false reassurance of a system designed for very different circumstances.

Key Words

Custody; Assessment; Health; Detainee; Warning Scores

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Professor Vanessa Webb- Conceptualization. Methodology. Data Curation. Investigation. Supervision.

Peter Kevern- Formal Analysis. Supervision

Tim Miles- Writing original draft, review and editing. Project Administration.

Tom Bird- Project Administration. Investigation.

Raj Shibchurn- Project Administration. Investigation.

George Finch- Project Administration. Investigation.

Disclosure

The authors report conflict of interests:

Professor Vanessa Webb is the Founder of Mountain Healthcare and is a significant shareholder.

Tim Miles is the Research Lead of Mountain Healthcare and a full time employee.

Tom Bird, Raj Shibchurn and George Finch are full time employees of Mountain Healthcare Ltd

Funding

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors although was undertaken by Mountain Healthcare Ltd.

Thanks to Surrey Police Force for facilitating this research.

To evaluate the effectiveness and predictive accuracy of the National Early Warning Score and the Custody Early Warning Score in predicting deterioration of patients in police custody.

Abstract

When a person is booked into police custody in the United Kingdom, they undergo a risk assessment, conducted by custody sergeants. With deaths and serious incidents continuing to occur, some forces are looking to add Custody Early Warning Scores, based on the National Early Warning Score. The introduction of this scoring system has not been evaluated in police custody. This therefore formed the basis of this study, considering whether this scoring tool was effective when used by non-medical staff to monitor those under arrest. The modified scoring system may be insensitive to the specific health problems of those detained, given the frequent use of alcohol, stimulating and sedating drugs, and sometimes, the forceful nature of the arrest, all resulting in physiological changes making scoring potentially unreliable and possibly insensitive.

We were also concerned that a 'good' score would give false reassurances to staff and that there would also be false negative and false positive scores; clouding the health picture.

We also tested the correlation between these different systems; National Early Warning Score Vs Custody Early Warning Score to see if one method was more sensitive than the other and if either showed an advantage in a custodial setting.

Results

1'163 detainees were assessed by medical staff with both the National Early Warning score and Custody Early Warning Score measured.

The majority of hospital referrals (28%) had a CEWS score of just 1 whilst those with a score of zero (22%), still led to referrals which on reviewing the medical records justified referral. In the majority of hospital referral cases, detainees were referred on clinical judgement despite a usually lower CEWS score. Chest pain, head injury, overdose of substances, drug concealment and diabetic ketoacidosis being the main reason for referral, all of which had lower NEWS and CEWS scores.

Higher CEWS scores of 4 or 5, which would imply notable pathology requiring further assessment, constituted just 2.7% and 5.5% respectively. There is a small correlation with scores of above 4 and referral to hospital, but it is suspected that such referrals would have been identified due to clinical judgement of the presenting condition.

Conclusions

Life threatening conditions have low assessment scores, which was not reflective of the seriousness of any medical conditions. There appeared to be no worsening of scores triggering clinical review which is the purpose in a hospital setting. Whilst we found a small correlation between increased Custody Early Warning Scores above 4 and referral to hospital; such scores add little to the risk assessment process as other indicators were triggering ED referral. Low scores could allow for complacency and a false reassurance leading to failure to seek medical advice or consider 999 referral.

Key Words

Custody; Risk Assessment; Early Warning Scores

To evaluate the effectiveness and predictive accuracy of the National Early Warning Score and the Custody Early Warning Score in predicting deterioration of patients in police custody.

Patient deterioration and Serious Adverse Events (SAEs) such as sudden cardiac arrest or sepsis are preceded by subtle changes in basic physiological parameters and mental status. Studies have reported that evidence of clinical deterioration; detectable by the worsening of those parameters, is often present several hours before the occurrence of SAEs, which has led to the development of tools for the early recognition of patients at risk of deterioration (Brangan et al 2018).

To detect these changes, Early Warning Score (EWS) systems, are used throughout the NHS, as recommended by the Royal College of Physicians Acute Medicine Task Force report; *Acute Medical Care; the right person, in the right setting- first time* (RCP 2007). This recommended a standardised, easy to use warning system to better identify patients at risk of clinical deterioration; to affect more timely intervention and thus save lives. From this, the National Early Warning Score (NEWS) was launched in 2012.

NEWS acts as a simple adjunct to describe the clinical condition of a patient and track physiological changes, with it more recently functioning as a common language between departments and services, easily identifying the more serious patient. This standardised measuring tool can be interpreted consistently, with rising scores indicating the need for intervention. It is used for initial assessment, as well as continuous monitoring, identifying clinical deterioration and providing a trigger for escalation of care. Since its launch, its uptake within the NHS has been extraordinary, with the majority (NHS England 2018) of NHS acute hospitals now using the system, along with ambulance and primary care (Williams, 2017).

In December 2017, an updated version of NEWS was published; NEWS 2. This resulted in improved vital sign recording of as well as recognising the importance of new onset confusion and the reinforcement of the value of aggregate scores versus single parameter recordings. Like NEWS before it, it is based on a simple aggregate scoring system in which a score is allocated to physiological measurements. NEWS 2 comprises a simple calculation method, based on the physiological parameters of respiratory rate, pulse rate, systolic blood pressure, oxygen saturation, the presence of oxygen supplementation, and neurological status (RCP 2012). To date, few studies are available describing specific interventions according to this and although there is usefulness in the shared understanding of physiological measures, there is limited evidence of its pre-hospital effectiveness (Pirneskoski, et al. 2017).

The NEWS 2 (commonly known as just *NEWS*) system is a Care Quality Commission compliance indicator during hospital inspections, as it has been found to be effective and work well, with improved patient outcomes and lives saved (CQC 2018). NHS England, with the support of NHS Improvement have fully endorsed NEWS and have mandated its use to 100% of acute trusts and ambulance settings by March 2019, with all acute hospitals mandated to transition to its use. Its use is encouraged within mental health trusts and its use in the community is undergoing an evidence gathering process (NHS England 2018), although it is emphasised that it should be used alongside other sources of clinical information (Brangan, et al 2018).

Risk assessment in police custody is a complex task, requiring patience and an effective screening tool. It is not within the scope of this research to comment on the national risk assessment tool currently used; our aim of this study was to evaluate the effectiveness and predictive accuracy of the National Early

Warning Scores (NEWS) and the Custody Early Warning Score (CEWS) as a predictor, to detect deterioration of patients in police custody, which can be a challenging environment making the clinical picture difficult to interpret, with substance misuse and alcohol dependency, mental health, fabricated illnesses, self-harm, wider vulnerabilities and complex needs increasing health risk, whilst the custodial population is recognised as having greater morbidity than the population average (McKinnon, et al. 2016).

CEWS scoring consists of the following;

- Oxygen saturations
- Pulse rate
- Alertness to rousing
- Pupil size
- Behaviour

This differs somewhat to NEWS scoring, which consists of;

- Oxygen saturations
- Pulse rate
- Respiratory rate
- Temperature
- Use of supplemental oxygen
- Systolic blood pressure
- AVPU

Methods

Phase-1

Clinical observations were recorded upon arrival into custody or shortly after. These values were converted into NEWS and CEWS score by the research staff. Clinicians, who were a mix of doctors, nurses and paramedics, did not alter their current practice and therefore continued to use clinical judgement to determine;

- No further assessment
- More detailed assessment
- Referral to hospital

Phase-2

Those identified by the police risk assessment as requiring further intervention had vital signs recorded, which were again converted into NEWS and CEWS score by research staff, using the raw data alone. The outcome options from this were;

- No further assessment required following brief triage
- A more detailed assessment required and any treatment decided
- Hospital referral following clinical assessment

Phase-3

Those individuals who were referred to hospital had clinical findings recorded, which were again converted into CEWS and NEWS scores. Data was obtained from the clinical incident reporting system, which included routinely reporting all hospital referrals. Their NEWS/CEWS score were again calculated from clinical findings. Through the review of all hospital referrals, the correlation between NEWS/CEWS was calculated.

To ensure any bias was minimized, scoring was not undertaken by the clinician. To avoid any confirmation bias, we used practitioners who were normally on duty. Staff were aware of the research, but only in so much as to provide a consistent approach with reliable data. They were unaware of any early results and could not access finished data. Some were familiar with NEWS from previous areas of employment but none had used NEWS or CEWS in police custody. Therefore, there was very little confirmation or first impression bias. Three people correlated the data from the medical records.

All clinicians undertook assessments and we have not stratified to different professional groups.

Results

1'163 detainees were assessed by medical staff with both the National Early Warning score and Custody Early Warning Score measured.

With NEWS scores alone, we found that of the total number of assessments carried out, 58% scored just 0, whereby 2.8% scored 3, and a score of 4 was seen in only .95% of people. However, in the category of patients scoring 1 and 2, we found these correlated to 28% and 11%, of those assessed. Looking at CEWS scores alone, with the same cohort of people; we found that CEWS scores of; 48% scoring just 1, just 4% scoring 3, less than .5% scoring 4 and only .2% scoring 5

276 detainees were referred to hospital and using this data, converting the number of admissions with each score to number of admissions per 1000 people with each score results in;

NEWS score	Admissions per 1000 with this score;
0	24.3
1	30.6
2	25.2
3	142.9
4	166.7

5	1000
CEWS score	Admissions per 1000 with this score;
0	15.6
1	34.5
2	63.6
3	100
4	166.7

Although there is a correlation between high scores and requirement for hospital admission, this progression suggests that CEWS and NEWS can't predict outcomes with certainty; which is the nature of risk and the essence of the police risk assessment.

Custody sergeants should certainly pay attention to people with scores of 3 or above on either CEWS or NEWS systems, as there is at least a 10% chance they will require hospital admission however lower scores could have life threatening events and high scores were rare.

Data Analysis

When looking at NEWS scores alone, we found that of the total number of assessments carried out, 58% scored 0, whereby 2.8% scored 3, and a score of 4 was seen in 0.95% of people. However, in the category of patients scoring 1 and 2, we found these correlated to 28% and 11%, of those assessed.

When looking at CEWS scoring of the same cohort again, the majority of hospital referrals (28%) had a CEWS score of just 1 whilst those with a score of zero (22%), still led to referrals which on reviewing the medical records; were justified, 10% of those referred scoring 3 (a low figure), 3% scoring 4 and 5% scoring 5.

Chest pain, head injury, overdose of substances, drug concealment and diabetic ketoacidosis being the main reason for referral, all of which had lower NEWS and CEWS scores.

Higher NEWS/CEWS scores of 4, 5 or 6, which would imply notable pathology requiring further assessment, constituted less than 6% respectively. There is a small correlation with scores of above 3 and referral to hospital, but it is anticipated that such referrals would have been identified due to clinical judgement of the presenting condition.

So, the majority of those referred to hospital generally have a NEWS or CEWS score of <2.

Listed in order of commonality of hospital referral, we see the top-5 reasons for hospital referral of the 276 cases over the study period;

- Head Injury (25-cases. 9.0%), average CEWS score; 4
- Overdose (24-cases. 8.7%), average CEWS score; 2
- Diabetic Ketoacidosis (8-cases. 2.9%), average CEWS score; 2
- Drug concealment (pre-determined swallowing or rectal packing, 22-cases. 7.8%), CEWS 2

- Chest pain (48-cases. 17.4%), average CEWS score; 1

This gives the mean CEWS score of the top five referral reasons at 2.2.

Discussion

Several assessment tools based on vital signs have been developed for the early screening of patients at risk of clinical deterioration. A recent meta-analysis demonstrated that introducing an early warning score did not significantly improve mortality or SAEs (Sutherasan, et al. 2018), however, those results may be due to the use of modified forms of the Early Warning Score together with different thresholds and methodology, making it difficult to compare between studies.

We are reminded that such track and trigger systems are used to support clinical judgement, not drive it. In a non-clinical setting the understanding of the physiology and consideration of monitoring and reviewing changing scores is not understood.

When used in the hospital setting, which is its original purpose, increased NEWS at admission is associated with death and ICU transfer within 2 days after admission. NEWS also performs better than other scoring systems for assessing medical risk in hospital settings; nevertheless, its impact on patient outcomes has not been fully investigated.

The main purpose for applying a triaging system in custody is earlier detection of patients at risk of deterioration and to provide appropriate custodial management, which includes consideration of early removal to hospital. The embedded service with a clinician always available, did not change practice and there was no indication of a missed opportunity to transfer a person earlier in their detention.

Using NEWS/CEWS, it was not anticipated that overall patient outcomes would have been improved and the higher percentage of low scores that require hospital review would suggest this is not an appropriate tool for custody.

We did not consider the other considerations that might impact on the use of NEWS/CEWS:

- Medical devices policy with the appropriate training for use of pulse oximeters.
- Alert fatigue, defined by Capan, et al (2018) as triggered alerts being used as a process, wherein clinicians may inadvertently ignore clinically useful alerts, thus diminishing the effectiveness of the scoring system.
- Increase or decrease in rousing which form an underlying principle of best practice in the high risk patient.
- The identification as 'straight to cell' as a risk factor which was noticed as a possible correlation for requirement for hospitalisation.

Limitations

There were three main limitations in this study.

- First, we did not control patients in the groups to have the same overall disease severity and prognosis. Consequently, the percentages of moderate and high risk patients were higher in the stage-2 protocol group. Moreover, the ICD-10 diagnoses differed between groups.

- The fact that the groups were observed over different months, could give concern that there could be seasonal presentation of some symptoms.
- This work was conducted in a real-world setting in which it was not possible to recruit patients in a randomized fashion. A single-centre randomized control trial should be conducted in which both the control and protocol groups are selected from patients during the same time period and to which patients are randomly assigned. The cluster multicentre randomized control trial may be another solution.
- We did not analyse the protocol adherence and compliance of the clinical staff, which may have also affected the outcome or take into account any previous experience with scoring systems.

Conclusions

There is some degree of correlation between NEWS/CEWS scoring and a referral to hospital from police custody, however it is very difficult to estimate how this would impact on the outcomes of those detained, as many low scoring requirements for hospital review may be missed. Using CEWS or NEWS in Custody can therefore be falsely reassuring whilst missing those deteriorating.

The clinical picture is further complicated when we consider the nature of arrest, the co-morbidities present, substance and alcohol dependency, drug concealment, mental health and wider vulnerabilities which can include the use of incapacitant sprays and electrical stun weaponry. Even the act of fleeing from police, being pursued and apprehended without any further use of force would still alter scoring parameters for some hours following arrest.

It is recognised the importance of identifying accurate systems for managing those detained in police custody. It is recognised that deaths in custody do occur and are often associated with drug and alcohol consumption (Angioloni 2017). This therefore is an important area to develop research to evaluate these systems and consider wider monitoring strategies.

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