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A Quantitative Study Investigating the Effects of Computerised Clinical Decision Support in the Emergency Department

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Abstract. This paper describes the evaluation of a computerized clinical decision support system (CCDSS) for Emergency Department (ED) triage. The CCDSS for triage was developed as a means to improve ED quality and safety. Whilst there is significant research on the role of CCDSS in health care, their role in EDs remains under-investigated. In this study, a CCDSS for ED triage was developed and evaluated using a quasi-experimental interrupted time-series design. Data was collected at four time points before and after the introduction of the CCDSS to assess key aspects of quality and safety within the ED. The results demonstrated a statistically significant improvement in triage prioritization ($p<0.001$), pain scoring ($p<0.001$) and pain management ($p<0.001$). This study clearly identifies the positive clinical impact that a CCDSS can have on quality and safety for ED patients and provides a unique contribution to the current knowledge base.

Keywords. Emergency Department, triage, clinical decision-support, CCDSS, interrupted time-series

1. Introduction

The demand for emergency care has risen exponentially over the last decade, both in the UK NHS and internationally [1, 2]. Several authors cite the challenges of the ED environment, including multiple interruptions, complex patients and overcrowding, as the impetus for the development of CCDSSs [3-6]. Within UK EDs the challenges of increasing demand and the achievement of performance targets have become significant issues for patients, clinicians and politicians over the last decade [7]. The triage CCDSS in this research study was developed as a means of supporting the delivery of safe, effective emergency care against a backdrop of rising patient attendances and staff shortages.

The triage CCDSS was developed in-house by engineers and ED clinicians. The lead clinician ensured that the clinical and operational needs of the users within ED were met. CCDSSs developed with users are strongly associated with high levels of user acceptance [8]. During its three years of operation from 12/04/2010 to 17/06/2013 the system handled the ED attendances of 293,206 patients.

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The overall objective of the triage CCDSS was to improve ED quality and safety. It would achieve this by providing, at the point of face-to-face triage, decision-support for prioritization, pain assessment and pain management. It would also provide a direct accessible link to the departmental clinical guidelines relevant to the patient presentation.

2. Methods

The triage CCDSS had been introduced as an intervention to support increased demand and to mitigate the threats to quality and safety that increased activity and clinician inexperience may produce. A quasi-experimental interrupted time-series (ITS) design was selected after careful consideration of alternative quantitative designs identified by Cochrane Effective Practice and Organisation of Care Group (EPOC) [9].

The statistical analysis compared the pre- and post- CCDSS groups. If large effects are demonstrated this can provide convincing evidence of the effect of an intervention [10]. However, to improve the quality of the study and reduce bias a time series design, with regression, was used to evaluate changes over time based on the methods used by Buising et al [11]. ITS design cannot determine cause and effect in the same way that a true experiment can [12]. However, it can establish whether an intervention is associated with a sustainable statistically significant change or not.

2.1. Research Question

The research question was: Does the introduction of a triage CCDSS improve the quality of triage decisions and safety within the ED?

2.2. Aims and objectives of the research

The aim of the research was to test the assumption that a CCDSS at the point of triage is an effective means of improving the quality and safety of clinical care in ED. The research objectives were

1. To compare the decision making of triage nurses before and after the introduction of the CCDSS
2. To compare the quality of pain assessment and management before and after the introduction of the CDSS
3. To investigate the ability of the CCDSS to improve the care of patients with potential neutropenic sepsis, a condition associated with significant morbidity and mortality

2.3. Setting and sample

This research was undertaken in a busy district general hospital ED in the north of the UK with an annual attendance in 2012 of 90,081. A random sample of 100 triage records was taken every third month for a year prior to the launch of the CCDSS

(2009-2010). One year post implementation a further random sample of 100 triage records was taken every third month for another year (2011-2012). A gap of one year between the data collection points enabled staff to become accustomed to using the CCDSS and any technological problems to be resolved. This ensured that data was collected on a stable CCDSS with which staff were familiar.

2.4. Data collection

The total sample size was 800; 400 records taken prior to implementation and 400 records afterwards. The design of this study also ensured that the basic EPOC [9] criteria for ITS studies deemed suitable for inclusion in their reviews were met: 1) there is a clearly defined time point when the intervention started 2) there is the collection of data from at least three data points before and after the intervention.

To evaluate the ability of the triage CCDSS to improve the safety of patients presenting with possible neutropenic sepsis, the care of all patients that presented during the two 12 month study periods was reviewed (1/4/2009-31/3/2010 and 1/4/2011-31/3/2012). Patients with confirmed neutropenia (neutrophil count <1.0) who had attended the ED were identified from the hospital's haematology database.

Data was collected by retrospective case note review to assess the accuracy of triage decisions as outlined previously.

2.5. Data analysis

Data was analysed using SPSS (20.0). Descriptive statistics were used to characterize the samples. Inferential statistics were used to draw conclusions about the data and test differences between the pre- and post- triage CCDSS groups. Regression analysis was used to adjust for confounding variables and expose the underlying secular trend.

2.6. Ethics and research governance

Ethical approval for the study was obtained from the University of Salford Research Ethics panel in 2010. NHS ethical approval was not required as there was no risk to patients and the research constituted service evaluation.

3. Results

The following results demonstrate the impact of the triage CCDSS on: triage prioritization, pain assessment, pain management and management of patients with potential neutropenic sepsis.

3.1. Triage prioritization

Correct triage prioritization pre CCDSS was 60.5% versus 85.2% post CCDSS; $\chi^2 = 60.70$; $p<0.001$.

3.2. Pain assessment and management

Pain assessment pre CCDSS was 35% versus 97.7% post CCDSS; χ^2 = 350.04; p<0.001. Appropriate analgesic administration pre CCDSS was 26.6% versus 78.5% post CCDSS; χ^2 = 216.80; p<0.001

3.3. Management of patients with neutropenic sepsis

Administration of intra-venous antibiotics within 1hour pre CCDSS was 11.5% versus 5.6% post CCDSS; χ^2 = 4.55; p<0.47

3.4. Regression analysis

The regression analysis demonstrates that in the pre CCDSS there was no evidence of any "correct priority" trend. Immediately post CCDSS there is a much greater "correct priority" percentage than expected for the extrapolation point at 24 months.

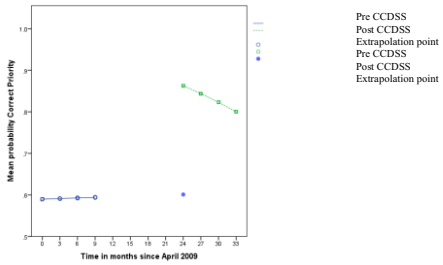

Figure 1. Fitted time trends of correct priority

4. Discussion

The potential for a triage CCDSS to remind triage nurses and assist them with critical decisions about patient management are evident from the results of this study. However the wider impact of the system beyond triage was not demonstrated by the results from the neutropenic sepsis cohort. Possible explanations are the design of the system, the small sample size, or both and further research is warranted.

This study adds to the limited body of published research on the impact of CCDSSs in emergency care. The results of this research support the initial assumption that the triage CCDSS would improve the quality and safety of triage decision-making. The use of an ITS design demonstrates that the improvements to patient management are above what would be expected if the CCDSS had not be introduced. The results of this research provide a unique and significant contribution to the existing CCDSS knowledge base.

It is well documented that the wholesale adoption of technology in health care is not always based on robust evidence [13, 14]. This research seeks to redress this balance for clinicians working in emergency care. The importance of rigorous evaluation of any system cannot be over-emphasized. This ensures that clinicians and managers are aware of how and when the system can improve upon existing quality

and safety strategies, and when they cannot. Those embarking upon CCDSS developments should ensure that their systems are based on functionality that has been shown to improve effectiveness [15, 16].

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References

[1] Kings Fund. *Are accident and emergency attendnaces increasing*? 2013 [cited 2013 22 October]. Available from: http://www.kingsfund.org.uk/blog/2013/04/are-accident-and-emergency-attendances-increasing.

[2] U Hwang, B Harris, RS Morrison, LD Richardson. The Effect of Emergncy Department Crowding Factors on Pain Management. *Annals of Emergency Medicine*. 2006;48(4, Supplement):117.

[3] CM Bond, D Djogovic, C Villa-Roel, MJ Bullard, DP Meurer, BH Rowe. Pilot Study Comparing Sepsis Management with and without Electronic Clinical Practice Guidelines in an Academic Emergency Department. *The Journal Of Emergency Medicine*. 2013;44(3):698-708.

[4] JW Dexheimer, TJ Abramo, DH Arnold, KB Johnson, Y Shyr, F Ye et al. An asthma management system in a pediatric emergency department. *International Journal of Medical Informatics*. 2013;82(4):230-8.

[5] MA Gibbs, MR Baumann, J Lyden, TD Strout, D Knowles. Effect of the implementation of an electronic clinical decision support tool on adherence to joint commission pneumonia core measures in an academic emergency department. *Academic Emergency Medicine*. 2012;19:S198-S9.

[6] J Nelson, BL Smith, JD Jared, JG Younger. Prospective Trial of Real-Time Electronic Surveillance to Expedite Early Care of Severe Sepsis. *Annals of Emergency Medicine*. 2011;57(5):500-4.

[7] M Cooke, J Fisher, J Dale, E McLeod, A Szczepura, P Walley et al. Reducing Attendances and Waits in Emergency Departments. A systematic review of present innovations. *Report to the National Co-ordinating Centre for NHS Service Delivery and Organisation R & D* (NCCSDO)2004 18 July 2013. Available from: http://wrap-test.warwick.ac.uk/134/1/WRAP_Szczepura_29-final-report.pdf.

[8] AX Garg, NKJ Adhikari, H McDonald, MP Rosas-Arellano, PJ Devereaux, J Sam et al. Effects of Computerised Clinical Decision Support Systems on Practitioner Performance and Patient Outcomes. *The Journal of the American Medical Association.* 2005;293(10):1223-38.

[9] EPOC. *What study designs should be included in an EPOC review and what should they be called*? 2013 1 Feburary 2014. Available from: http://epoc.cochrane.org/sites/epoc.cochrane.org/files/uploads/05 What study designs should be included in an EPOC review 2013 08 12.pdf.

[10] C Brown & R Lilford. Evaluating service delivery interventions to enhance patient safety. *British Medical Journal.* 2008;337(dec17 1):a2764-a.

[11] KL Buising, KA Thursky, JF Black, L MacGregor, AC Street, MP Kennedy et al. Improving antibiotic prescribing for adults with community acquired pneumonia: Does a computerised decision support system achieve more than academic detailing alone? - A time series analysis. *BMC Medical Informatics and Decision Making*. 2008;8:35.

[12] T Sheldon, N Cullum, D Dawson, A Lankshear, K Lowson, I Watt et al. What's the evidence that NICE guidance has been implemented? Results from a national evaluation using time series analysis, audit of patients' notes, and interviews. *British Medical Journal*. 2004;329(7473):999.

[13] AD Black, J Car, C Pagliari, C Anandan, K Cresswell, T Bokun et al. The Impact of eHealth on the Quality and Safety of Health Care: A Systematic Overview. *PLoS Medicine*. 2011;8(1):e1000387.

[14] RB Haynes & NL Wilczynski. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: methods of a decision-maker-researcher partnership systematic review. *Implementation Science*. 2010;5:12.

[15] D Lobach, G Sanders, T Bright, A Wong, R Dhurjati, E Bristow et al. Enabling Health Care Decisionmaking Through Clinical Decision Support and Knowledge Management. Evidence Report No 203 Rockville: *Agency for Healthcare Research and Quality*; 2012 [cited 2014 17 March]. Available from: http://www.ahrq.gov/research/findings/evidence-based-reports/er203-abstract.html.

[16] P Roshanov, N Fernandes, J Wilczynski, B Hemens, J You, S Handler et al. Features of effective computerised clinical decision support systems: meta-regression of 162 randomised trials. *British Medical Journal*. 2013;346