

agreement was achieved for 554 (75.0%) patients pre-eCTAS, compared to 429 (93.0%) patients triaged with eCTAS. Using the auditors CTAS score as the reference standard, eCTAS significantly reduced the number of patients over-triaged (12.1% vs. 3.2%; 8.9, 95% CI: 5.7, 11.7) and under-triaged (12.9% vs. 3.9%; 9.0, 95% CI: 5.9, 12.0). Interrater agreement was higher with eCTAS (unweighted kappa 0.90 vs. 0.63; quadratic-weighted kappa 0.79 vs. 0.94). Research assistants captured triage time for 4403 patients pre-eCTAS and 1849 post implementation of eCTAS. Median triage time was 304 seconds pre-eCTAS and 329 seconds with eCTAS (25 seconds, 95% CI: 18, 32 seconds).

**Conclusion:** A standardized, electronic approach to performing CTAS assessments improves both clinical decision making and administrative data accuracy without substantially increasing triage time.

**Keywords:** triage, electronic Canadian Triage and Acuity Scale, interrater agreement

### LO71

#### Implementation strategies to promote provider behaviour change in emergency departments

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**Introduction:** Translating research evidence into routine clinical practice in emergency departments (EDs) often requires changing the behavior(s) of one or more member of the healthcare team. Changing strongly entrenched behavior patterns or occasional behaviors that are impacted by psychological, social or environmental factors can be challenging. We conducted a systematic review of the literature to identify implementation strategies that have been evaluated to change ED provider behavior and promote the uptake of evidence in emergency practice settings. **Methods:** The following databases were systematically searched from inception to 2017 with the support of a library scientist: MEDLINE, CINAHL, Embase and Cochrane CENTRAL. We also manually searched the last 5 years of Annals of Emergency Medicine, Canadian Journal of Emergency Medicine, and Implementation Science. Studies were assessed by two independent reviewers and retained if they included one or more of the implementation strategies listed in the Cochrane Effective Practice and Organization of Care (EPOC) Taxonomy, targeted any health care provider working in any type of emergency department. The Cochrane Risk of Bias tool was used to assess study quality. **Results:** Following review of 13,000 title and abstracts, 33 studies met the inclusion criteria. The majority of included studies were randomized control trials (N=32) and 50% were published in the last seven years. Although poorly described, interventions targeted either physicians (n=12), nurses (n=8), pharmacists (n=1) or multi-disciplinary teams (n=12). Common behavioral targets included compliance with practice guidelines, test ordering and prescribing. According to the EPOC Taxonomy most implementation strategies were multi-component and could be categorized as either educational materials/meetings and/or reminders. Only one study author reported using evidence to inform the design of the implementation strategy. Effect sizes varied across relevant study outcomes but the direction of effect was positive in 22/33 included studies. Heterogeneity of study interventions and outcomes precluded meta-analysis. **Conclusion:** To strengthen the evidence base regarding implementation strategies that promote provider behavior change across different ED contexts, there is a critical need to improve both the design and reporting of implementation strategies in ED research.

**Keywords:** implementation science, healthcare provider behaviours, evidence-based practice

### LO72

#### A randomized controlled trial of electronic clinical decision support to reduce unnecessary CT imaging for patients with mild traumatic brain injury

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**Introduction:** Utilization of CT imaging has risen dramatically with increases in availability, but without corresponding improvements in patient outcomes for many clinical scenarios. Previous attempts to improve imaging appropriateness have met with limited success, with commonly cited barriers including a lack of confidence in patient outcomes, medicolegal risk, and patient expectations. The objective of this study was to assess the impact of an electronic clinical decision support (CDS) intervention to reduce CT utilization for emergency department (ED) patients with mild traumatic brain injury (MTBI). **Methods:** This was a cluster-randomized, controlled trial with physicians as the unit of randomization. All emergency physicians (EPs) at 4 urban adult EDs and 1 urgent care center were randomly assigned to receive evidence-based imaging CDS (intervention) or no CDS (control) for patients with MTBI over a 1-year study period. CDS was launched in an external web browser whenever an intervention EP ordered a non-enhanced head CT from the computerized physician order entry (CPOE) system for ED patients CTAS 2-5 with a CEDIS chief complaint of head injury; however, interaction with CDS was voluntary. The CDS tool provided detailed information to physicians about the Canadian CT Head Rule, including patient eligibility, exclusion criteria, risk factors and probability of serious injury, as well as an imaging recommendation (yes/no). CDS recommendations could be printed for the medical record as could educational patient handouts to support physician decision making. The primary outcome was CT utilization for patients with MTBI on the index visit. Secondary outcomes included ED length of stay (LOS), and return visits, CT use, hospital admission and traumatic head injury diagnoses over the next 30-days. This study was REB approved. **Results:** Physician demographics and baseline CT utilization for MTBI patients were similar among intervention and control EPs during a 2-year pre-intervention period. In the first 8-months following CDS implementation, 102 intervention EPs saw 2,189 eligible patients while 100 control EPs saw 1,707 patients. Intervention EPs voluntarily interacted with CDS on 36.2% of eligible encounters. Head CT utilization was lower among intervention EPs than controls (38.5% vs. 45.1%,  $p < 0.0001$ ) as was ED LOS (201 vs. 218.5 minutes,  $p < 0.001$ ). There was no difference in 30-day ED return visits, head CT utilization, hospital admission or traumatic head injury diagnoses. **Conclusion:** In one of the largest RCTs of CDS to date, exposure to CDS was associated with decreased head CT utilization and shorter LOS on the index visit, and no difference in 30-day head CT use, return ED visits or hospital admission. These results suggest that a comprehensive CDS implementation may be able to overcome several barriers to use of decision rules and may contribute to improved clinical decision making and decreased CT utilization.

**Keywords:** clinical decision support, diagnostic imaging, mild traumatic brain injury

### LO73

#### A randomized controlled trial of electronic clinical decision support to reduce unnecessary CT imaging for patients with suspected pulmonary embolism

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**Introduction:** Utilization of CT pulmonary angiography (CTPA) to rule out pulmonary embolism (PE) has risen dramatically but diagnostic yield has fallen over the past several decades, suggesting that lower risk patients are being tested. Given little evidence to suggest improved patient outcomes with higher CTPA utilization, and increasing evidence of harm, evidence-based guidelines have been developed to reduce unnecessary CTPA use. The objective of this study was to assess the impact of an electronic clinical decision support (CDS) intervention to reduce unnecessary CTPA utilization for emergency department (ED) patients with suspected PE. **Methods:** This was a cluster-randomized, controlled trial with physicians as the unit of randomization. All emergency physicians (EPs) at 4 urban adult EDs and 1 urgent care center were randomly assigned to receive either evidence-based imaging CDS for patients with suspected PE (intervention) or no CDS (control) over a 1-year study period. CDS was launched in an external web browser whenever an intervention EP ordered a CTPA from the computerized physician order entry software for ED patients CTAS 2-5; however, physician interaction with CDS was voluntary. The CDS tool enabled calculation of patient-specific information, including the patients Wells score, PERC score, and age-adjusted D-dimer, as well as prediction of each patients pre-test risk of PE along with an imaging/no imaging recommendation. CDS recommendations could be printed for the medical record as could educational patient handouts to support physician decision-making. The primary outcome was CTPA utilization for patients with CEDIS chief complaints of shortness of breath or chest pain on the index visit. Secondary outcomes included index visit length of stay (LOS), and CTPA use or VTE diagnosis within 90-days. This study was REB approved. **Results:** Demographics were similar among intervention and control EPs; however, during a 2-year pre-intervention period control EPs had a higher baseline CTPA rate (8.5% vs. 7.7%,  $p < 0.001$ ). In the first 8-months following CDS implementation, 94 intervention EPs saw 9,609 patients and voluntarily interacted with the CDS tool on 43.2% of eligible encounters while 91 control EPs saw 9,498 patients. CTPA utilization was higher among intervention EPs than control (9.6% vs. 8.3%,  $p < 0.001$ ) as was ED LOS (302 vs. 287 minutes,  $p < 0.001$ ). There was no difference in 90-day CTPA use or VTE diagnoses. **Conclusion:** In one of the largest RCTs of CDS to date, exposure to CDS was associated with higher rates of CTPA utilization and longer ED LOS on the index visit, and no difference in 90-day CT use or VTE diagnoses. These results differ from a concurrent study of CDS for patients with mild traumatic brain injury in the same physician population and may relate to the implementation of the CDS intervention and/or complexity of the underlying evidence-based algorithms.

**Keywords:** clinical decision support, pulmonary embolism, diagnostic imaging

#### LO74

##### Cost-effectiveness of pathways for diagnosing pulmonary embolism in Canada

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**Introduction:** Pulmonary embolism (PE) is a common cardiovascular condition with high mortality rates if left untreated. Given the non-specific and varied symptoms of PE, its diagnosis remains challenging and approaches can lend themselves to inefficiencies through over-testing and

over-diagnosis. Clinicians rely on a multi-component and sequential approach, including clinical risk assessment, rule-out biomarkers, and diagnostic imaging. This study assessed the potential cost-effectiveness of different diagnostic algorithms. **Methods:** A cost-utility model was developed with an upfront decision tree capturing the diagnostic accuracy and a Markov cohort model reflecting the lifetime disease progression and clinical utility of each diagnostic strategy. 57 diagnostic strategies were evaluated that were permutations of various clinical risk assessment, rule-out biomarkers and diagnostic imaging modalities. Diagnostic test accuracy was informed by systematic reviews and meta-analyses, and costs (2016 CAD) were obtained from Canadian costing databases to reflect a health-care payer perspective. Separate scenario analyses were conducted on patients contra-indicated for computed tomography (CT) or who are pregnant as this entails a comparison of a different set of diagnostic strategies. **Results:** Six diagnostic strategies formed the efficiency frontier. Diagnosing patients with PE was generally cost-effective if willingness-to-pay was greater than \$1,481 per quality-adjusted-life year (QALY). CT dominated other imaging modality given its greater diagnostic accuracy, lower rates of non-diagnostic findings and lowest overall costs. The use of clinical prediction rules to determine clinical pre-test probability of PE and the application of rule-out test for patients with low-to-moderate risk of PE may be cost-effective while reducing the proportion of patients requiring CT and lowering radiation exposure. At a willingness-to-pay of \$50,000 per QALY, the strategy of Wells (2 tier) → d-dimer → CT → CT was the most likely cost-effective diagnostic strategy. However, different diagnostic strategies were considered cost-effective for pregnant patients and those contra-indicated for CT. **Conclusion:** This study highlighted the value of economic modelling to inform judicious use of resources in achieving a diagnosis for PE. These findings, in conjunction with a recent health technology assessment, may help to inform clinical practice and guidelines. Which strategy would be considered cost-effective reflected ones willingness to trade-off between misdiagnosis and over-diagnosis.

**Keywords:** health economics, methodology, diagnostic technologies

#### LO75

##### Utility of red flags to identify serious spinal pathology in patients with low back pain: a retrospective analysis

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**Introduction:** Practice guidelines discourage routine imaging for low back pain and recommend selective use when serious underlying conditions are suspected. Evidence about prevalence of serious pathologies and accuracy of red flags for decision-making is limited. We describe rates of serious low back pathology, assess the accuracy of three red flags and model the utility of combining administratively available red flags to reduce imaging. **Methods:** A seven-year retrospective study of patients presenting with low back pain to four emergency departments in Nova Scotia, Canada. Patient characteristics were available from administrative data. We test sensitivity, specificity, positive and negative predictive values, and likelihood ratios of individual and combinations of red flags. We use decision curve analyses to assess the clinical utility of three red flags to inform imaging. **Results:** We included data from 38,714 patients presenting with low back pain. Serious low back pathology was diagnosed in 1,196 (3.09%): 847 (2.19%) were vertebral fractures, 184 (0.48%) unstable fracture, 262 (0.68%) cancer, 57 (0.15%) cauda equina syndrome, and 30 (0.08%) spinal infection. Value of combining three red flags (age >65, female sex, and trauma) was found: positive likelihood ratios of 4.36 and 9.74 for vertebral fracture and unstable fracture, respectively. Imaging for