Supplemental Table 4. Interventions and Outcomes for the Eligible Studies

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Study  | Brief description of interventionand type of deterioration detected | Who was alerted and how | Difference in mortality in the intervention group compared to usual care (hospital mortality if not otherwise specified) | Difference in hospital LOS in the intervention group compared to usual care | Difference in ICU LOS in the intervention group compared to usual care |
| Al-Jaghbeer et al. 2018  | CDSS for automated detection of "possible AKI" based on creatinine (with alerts) | EHR based pop-up alert | Entire cohort and alert-positive: decreased significantly (adjusted OR 0.76 [0.70, 0.83] and OR 0.91 [0.86, 0.96]). No significant difference in non-alerted patients (OR 0.96 [0.91, 1.02]) | Entire cohort and alert-positive: decreased significantly (adjusted IRR 0.91 [0.89, 0.92] and MD -0.3 [-0.49, -0.11]) | NA |
| Bailey et al. 2013 | Java-based, rule based DSS algorithm for automated prediction of need for ICU transfer (with alerts) | Paged alert to nursing | No significant difference (entire cohort OR 1.00 [0.83, 1.21]; alert-positive\* OR 1.06 [0.81, 1.38]) | No significant difference (entire cohort MD 0.09 [-0.09, 0.27]; alert-positive MD 0.15 [-0.87, 1.17]) | NA |
| Berger et al. 2010 | Automated alert for SIRS criteria (possible sepsis) and reminder to order a serum lactate  | EHR based pop-up alert | Alert-positive: no significant difference (OR 0.90 [0.60, 1.35]) | NA | NA |
| Bourdeaux et al. 2020 | Computerized AKI decision support tool integrated with CCIS (with alerts), automated AKI guidelines, and staff education and training | EHR based pop-up alert | Entire cohort: no significant difference (OR 0.73 [0.57, 0.93])General ICU: no significant difference (OR 0.81 [0.61, 1.06])Cardiac ICU: decreased significantly (OR 0.40 [0.21, 0.79]) | Entire cohort: increased significantly (MD 1.60 [0.82, 2.38])General and cardiac ICU: increased significantly (MD 1.90 [0.27, 3.53] and 1.60 [0.89, 2.31]) | Entire cohort: no significant difference (MD 0.10 [-0.25, 0.45])General ICU: no significant difference (MD -0.40 [-1.07, 0.27])Cardiac ICU: increased significantly (MD 0.40 [0.01, 0.79]) |
| Colpaert et al. 2012 | Real-time electronic alert system (“AKI sniffer”) based on the RIFLE classificationcriteria integrated with CCIS | Paged alert to providers | Entire cohort: no significant difference (hospital mortality p=0.374, ICU mortality p=0.601, 28-day mortality p=0.331) | NA | Entire cohort: no significant difference (MD 0.20 [-0.66, 1.06]) |
| Escobar et al. 2020 | AAM program for real time EWS calculation  | EHR based pop-up alert for nurses, who performed initial chart review and contacted RRT | Alert-positive: hospital mortality and 30-day after alert mortality decreased significantly (OR 0.65 [0.60, 0.69] and adjusted RR 0.84 [0.78–0.90]) | Alert-positive: decreased significantly (MD -0.71 [-0.91, -0.51]) | NA |
| Evans et al. 2014 | Alert-generating automated case detection and response triggering system for patient monitoring and identifying early signs of physiologic deterioration based on vital signs and six mental status scores | Paged alert to nursing | Entire cohort: decreased significantly (OR 0.76 [0.59, 0.98])Decreased significantly in Unit A (OR 0.71 [0.54, 0.95]), no significant difference in Unit B (OR 0.88 [0.45, 1.69]) | Entire cohort: decreased significantly in Unit A (p=0.002), no significant difference in Unit B (p>0.05) | NA |
| Fogerty et al. 2019 | EHR monitoring and intervention tool for deterioration detection based on SIRS criteria (with alerts) | Paged alert to RRT | Entire cohort: no significant difference (p=0.07) | NA | NA |
| Gatewood et al. 2015 | Electronic sepsis alert and clinical decision support tool. | EHR based pop-up alert | Entire cohort: no significant difference (OR 0.82 [0.47, 1.43]) | NA | NA |
| Giannini et al. 2019 | “EWS 2.0” - Machine learning algorithm to predict sepsis, severe sepsis (with alerts)  | EHR-based alert to nursing, text message to providers and rapid response coordinator | Alert-positive: no significant difference in hospital and 30-day mortality (OR 0.97 [0.78, 1.20] and 0.96 [0.77, 1.19])  | Entire cohort and alert-positive: no significant difference (MD 0.00 [-0.13, 0.13] and 0.00 [-1.26, 1.26]) | Alert-positive: no significant difference (MD 0.58 [0.06, 1.11]) |
| Heller et al. 2020  | Automated MEWS-based Early Warning System with paging functionality | Paged alert to providers | Entire cohort: no significant difference (deaths 1000 G DRG case weight points 8.8 in intervention group vs 8.5 in control) | Entire cohort: no significant difference (MD -0.90 [-2.11, 0.31]) | NA |
| Hooper et al. 2012 | Listening Application - electronic tool designed for patient monitoring and identifying patients with SIRS criteria (with alerts) | EHR-based and paged alert to providers | Entire cohort: no significant difference (OR 1.49 [0.83, 2.67]) | Entire cohort: no significant difference (MD 1.00 [-0.84, 2.84]) | Entire cohort: no significant difference (MD 0.00 [-0.70, 0.70]) |
| Horton et al. 2020 | MEWS-based clinical decision support algorithm targeting early recognition of sepsis decompensation (with alerts) | EHR-based and paged alert to nursing | Entire cohort: no significant difference (p=0.26) | Entire cohort: no significant difference (MD -0.63 [-1.29, 0.03]) | NA |
| Huff et al. 2018 | NEWS-based electronic sepsis screening and alert tool | Electronic vital sign system-based pop-up alert | ICU mortality for patients transferred to the ICU within 24 hoursof admission: decreased by 23%; significantly decreased in patients with respiratory failure (p=0.015) and sepsis (p=0.005) | No significant difference (-22%, p>0.05) for all ICU admissions, significantly decreased in patients with respiratory failure and sepsis | NA |
| Kollef et al. 2014 | Electronic clinical decision support rules engine with real-time deterioration alerts | Paged alert to RRT | Alert-positive: no significant difference (OR 0.95 [0.51, 1.76]) | Alert-positive: decreased significantly (MD -1.00 [-2.70, 0.70]) | Alert-positive: no significant difference (MD -1.00 [-2.06, 0.06]) |
| Kollef et al. 2017 | Electronic clinical decision support rules engine (RTCDA prediction model) with real-time deterioration alerts | Paged alert to RRT | Entire cohort: decreased significantly (OR 0.92 [0.85, 0.99]),Significant year-to-year decrease  | Entire cohort: decreased significantly (MD -0.24 [-0.32, -0.16]),Significant year-to-year decrease | NA |
| Manaktala et al. 2017 | Quality improvement program including electronic CDS system for real-time sepsis surveillance of EHR data (with alerts) | Mobile application alert to nursing | Sepsis-related hospital mortality: decreased significantly (OR 0.47; [0.23, 0.99]) | Patients with sepsis: no significant difference (p>0.05) | NA |
| McCoy et al. 2017 | Machine learning-based algorithm generating a risk score for prediction of possible sepsis (with alerts) | EHR based alert followed by call to provider | Sepsis-related hospital mortality: decreased significantly (OR 0.38 [0/22, 0/65]) | Patients with sepsis: no significant difference (p=0.077) | NA |
| Mestrom et al. 2019 | Automatic MEWS calculation and monitoring for deterioration detection | Display of MEWS for nurses (on display of device and on monitor at central nurse station) | Entire cohort: no significant difference in hospital and 28-day mortality (OR 0.70 [0.17, 2.95 and 0.33 [0.07, 1.60]) | Entire cohort: no significant difference (MD -1.00 [-2.45, 0.45]) | Entire cohort: no significant difference (MD 0.00 [-0.16, 0.16]) |
| Olchanski et al. 2017 | ProCCESs AWARE - EHR-based dashboard for bedside clinical information management in the ICU (error prevention, practice surveillance and decision support) | EHR based pop-up alert for providers | Entire cohort: hospital and ICU mortality decreased significantly (OR 0.45 [0.29, 0.70] and 0.38 [0.22, 0.66]) | Entire cohort: decreased significantly (MD -3.90 [-5.00, -2.80]) | Entire cohort: decreased significantly (MD -1.60 [-1.97, -1.23]) |
| Park et al. 2018 | EHR-based AKI alert system with automatically generated nephrology consultation | EHR based pop-up alert for providers | Entire cohort: no significant difference in 30-day mortality (adjusted HR 1.07 [0.68, 1.68]) | NA | NA |
| Pickering et al. 2015 | AWARE - EHR-based dashboard for bedside clinical information management in the ICU (error prevention, practice surveillance and decision support) | EHR based pop-up alert for providers | Entire cohort: no significant difference (OR 0.70 [0.48, 1.02]) | Entire cohort: no significant difference (MD 0.80 [-0.64, 2.24]) | Entire cohort: no significant difference (MD 0.00 [-0.28, 0.28]) |
| Sawyer et al. 2011 | Sepsis alert-generating prediction tool using recursive partitioning regression tree analysis and alert system | Paged alert to nursing | Alert-positive: no significant difference (OR 0.86 [0.38, 1.96]) | Alert-positive: no significant difference (MD 2.00 [-1.63, 5.63]) | NA |
| Subbe et al. 2017 | Alert-generating NEWS- and CREWS-based monitoring system for detection of deteriorating patients  | Paged alert to nursing and RRT | Entire cohort: hospital and ICU mortality decreased significantly (OR 0.79 [0.63, 0.99]) and 0.26 [0.07, 0.92]) | Entire cohort: decreased significantly (MD -1.00 [-1.68, -0.34]) | NA |
| Umscheid et al. 2015 | EWRS for real time EHR labs and vitals monitoring and detecting patients at risk for deterioration and development of severe sepsis (with alerts) | Paged alert to providers and RRT, EHR based pop-up alert to nursing  | Entire cohort: no significant difference (OR 0.90 [0.76, 1.07])Alert-positive: no significant difference in hospital, ICU and 30-day mortality (adjusted OR 0.98 [0.63, 1.53], OR 0.87 [0.54, 1.40], and adjusted OR 0.87 [0.54–1.40]) | Entire cohort: no significant difference (adjusted LR coefficient 1.02 [0.93–1.12], Alert-positive: no significant difference (adjusted LR coefficient 0.88 [0.64–1.21]) | Entire cohort: no significant difference (MD -0.28 [-0.78, 0.09]),Alert-positive: no significant difference (adjusted LR coefficient 0.99 [0.76–1.28]) |
| Vizcaychipi et al. 2020 | Traffic-light driven EHR-based DSS for detection of increased risk of thromboembolism, cytokine storm, and respiratory deterioration/ARDS (with alerts) | EHR based pop-up alert for providers | Entire cohort: decreased significantly (OR 0.63 [0.43, 0.91]) | NA | NA |
| Weller et al. 2017 | Wireless body-worn monitor for continuous vital signs monitoring (with alerts) | Alert to nursing via smartphone | Entire cohort: no significant difference (p>0.05) | Entire cohort: no significant difference (p>0.05) | NA |
| Wilson et al. 2015 | Automated electronic alert for AKI based on creatinine  | Paged alert to providers and unit pharmacist | Entire cohort: no significant difference in hospital mortality and mortality at 7, 14, and 30 days after randomization (OR 1.05 [0.80, 1.38], 1.17 [0.82, 1.66], 1.09 [0.81, 1.48], and 0.98 [0.74, 1.30]) | Entire cohort: no significant difference (MD -0.30 [-1.63, 1.03]) | NA |
| Wilson et al. 2021 | Automated electronic alert for AKI based upon the creatinine  | EHR based pop-up alert | Entire cohort: no significant difference in mortality at 14 days after randomization: (OR and 1.00 [0.84, 1.19]) | Entire cohort: no significant difference (MD 0.10 [-0.43, 0.63]) | NA |
| Wu et al. 2018 | An automated electronic alert for AKI based on creatinine  | EHR based pop-up alert | Alert-positive: no significant difference (p=0.16). | NA | NA |
| \*Alert-positive = patients meeting the criteria for deterioration and therefore detectable by HIT both in intervention and control groups*Abbreviations*: LOS = length of stay; ICU = intensive care unit; CDSS= computerized decision support system; AKI - acute kidney injury; EHR = electronic health record; OR = odds ratio; IRR = incidence rate ratio; MD = mean difference; NA = not available; DSS = decision support system; SIRS = systemic inflammatory response syndrome; CCIS = critical care clinical information system; RIFLE = risk, injury, failure, loss of kidney function, and end-stage kidney disease; AAM = Advance Alert Monitor; EWS = early warning system; MEWS = modified early warning score; NEWS = National early warning score; RTCDA = real-time clinical deterioration alerts; CDS = clinical decision support; ProCCESs AWARE = Patient Centered Cloud-based Electronic System: Ambient Warning and Response Evaluation; CREWS = chronic respiratory early warning score; EWRS = early warning and response system; LR = linear regression |