Table B.5: Diagnostic Errors, Education and Training—Single Studies

Note: Full references are located in the [Section 1.3 reference list](#Section1point3refs).

| **Author, Year** | **Description of Patient  Safety Practice** | **Study Design; Sample Size; Patient Population** | **Setting** | **Outcomes: Benefits** | **Implementation Themes/ Findings** | **Risk of Bias (High, Moderate, Low)** |
| --- | --- | --- | --- | --- | --- | --- |
| **Coderre et al., 201020** | Use of querying an initial hypothesis to generate cognitive reflection in medical students | Pre/post study design with comparison groups; 67 first-year medical students | University of Calgary, Canada | Questioning an initial diagnosis through processing of additional data does not affect a correct initial diagnosis, but it does allow correction of an inaccurate initial diagnosis. | Not provided | Moderate |
| **Dyre et al., 201738** | Error management training (2 components: active exploration during skill practice and the provision of error management instructions) | Randomized trial; medical students with no prior ultrasound experience; 32 students received error management training (EMT) and 28 received error avoidance training (EAT) | Department of Obstetrics, Rigshospitalet, Denmark | Providing error management instructions, rather than error-avoidance instructions, during simulation-based training improved the transfer of learning to the clinical setting. Mean test scores in the transfer test corresponded to a large effect size in favor of EMT (Cohen’s d=1.11, 95% confidence interval [CI], 0.5 to 1.7). | Not provided | Low |
| **Goodman and Kelleher, 201732** | Focused session of interpretation training at a local art gallery where art experts taught the trainees how to thoroughly analyze a painting | Pre/post study design, no comparison group; 15 first-year radiology residents | Not provided | Focused teaching on perception improved first-year residents’ ability to localize imaging abnormalities. For the pretest, residents scored an average of 2.3 out of a maximum possible score of 15 (standard deviation (SD) of 1.4, range of 0–4). After training, average post-test score increased to 6.3 (SD of 1.8, range of 3–9)  (p < .0001). | Not provided | Moderate |
| **Mamede et al., 201017** | Structured reflection as taught through the use of five steps aimed at inducing reflective reasoning | Pre/post study design, with comparison group; 18 first-year and 18 second-year internal medicine residents | Erasmus Medical Centre, Rotterdam, Netherlands | When establishing diagnoses using nonanalytic reasoning, availability bias may occur in response to recent experience with similar cases. This bias may be counteracted by using reflective reasoning. Reflection improved all participants’ diagnoses compared with nonanalytical reasoning. | Reflective practice may take its full effect only with more difficult clinical scenarios. | Low to moderate |
| **Mamede et al., 201218** | Compared structured reflection with providing a single diagnosis or generating differential diagnoses while practicing clinical cases | Three-phase experimental study; 46 fourth-year medical students | Erasmus Medical Centre, Rotterdam, Netherlands | Using structured reflection to diagnose cases increases the learning of clinical knowledge more effectively than using immediate diagnosis or differential diagnosis generation. | Not provided | Low to moderate |
| **Mamede et al., 201419** | Compared structured reflection with providing a single diagnosis or generating differential diagnoses while practicing clinical cases | Two-phase experimental study; 110 fourth-year medical students | Erasmus Medical Centre, Rotterdam, Netherlands | Use of structured reflection was more effective in supporting learning than providing a single diagnosis or differential diagnoses. | Not provided | Low to moderate |
| **McFadden and Crim, 201641** | Online simulation-based training activity to improve diagnosis; training supplemented with interactive practice opportunities and feedback delivered by an artificial intelligence–driven simulation/tutor | Pre/post design with comparison group using convenience sampling; 68 practicing primary care practitioners (27 in control group, 41 in treatment group) | Continuing medical education (CME) conference (control group), standalone online CME (intervention group) | There was no difference between control and intervention groups in pre-training diagnostic accuracy. The control group’s post-training performance did not statistically significantly improve (p=.13); the intervention group’s post-training diagnostic performance significantly improved, by 22% (p<.02). | Not provided | Low |
| **Mohan et al., 201826** | Virtual simulation using two “serious” video games to train on the use of a heuristic, judgment by representativeness | A randomized controlled trial, using 257 board-eligible or board-certified emergency medicine physicians who worked primarily at non-trauma or level III/IV trauma centers | American College of Emergency Physicians Scientific Assembly | Both game interventions reduced under-triage events on the simulation compared with the control condition, whereas the text-based intervention did not. | Not provided | Low |
| **Nendaz et al., 201121** | Weekly in-person case-based clinical reasoning seminars incorporating diagnostic reflection | Randomized controlled study; 29 medical students (14 in the control group and 15 in the intervention group, providing 28 and 30 encounters, respectively) | University of Geneva Faculty of Medicine, Switzerland | The case-based clinical reasoning seminars did not significantly affect the students’ overall diagnostic or decisional competencies, but did aid in increasing the relevance of their differential diagnoses as written in the post-encounter notes. | Reflective practice may take its full effect only with more-difficult clinical scenarios. | Moderate |
| **Pusic et al., 201235** | Radiographic training sets, which varied in their proportions of abnormal cases (30%, 50%, 70%) | Prospective, double-blind, randomized, three-arm education trial; 100 residents completed the study | Six academic training programs for emergency medicine and pediatric residents, United States | The two groups did not differ in accuracy on the post-test (p=0.20). The group with a low proportion of abnormal cases had the highest false negative rate, and missed fractures one-third more often than the groups that trained on higher proportions of abnormal cases. Manipulating the ratio of abnormal to normal cases the students are exposed to can alter their sensitivity and specificity. | Online educational intervention | Low |
| **Reilly et al., 201322** | Three-part, 1-year curriculum in cognitive bias and diagnostic error | Pre/post study design with comparison group; 38 PGY-2 internal medicine residents | Perelman School of Medicine at the University of Pennsylvania, United States | Performance on the 13-item multiple-choice knowledge test improved post-curriculum when compared with both pre-curriculum performance (9.26 vs. 8.26, p=0.002) and the PGY-3 comparator group (9.26 vs. 7.69, p<0.001). Residents who participated in this curriculum improved their recognition and knowledge of common cognitive biases and heuristics. | Not provided | Moderate |
| **Schwartz et al., 201039** | Four weekly case-based 1-hour in-person didactic sessions to help the students develop knowledge and skills in contextualizing patient care | Quasi-randomized controlled trial; 124 fourth-year medical students in internal medicine sub-internships | University of Illinois at Chicago and Jesse Brown Veterans Administration Medical Center, United States | Students who participated in the contextualization workshops were significantly more likely to probe for contextual issues in the standardized patient encounters than students who did not, and significantly more likely to develop appropriate treatment plans for standardized patients with contextual issues. | Not provided | Moderate |
| **Sherbino et al., 201114** | A 90-minute, standardized, interactive, case-based teaching seminar on cognitive forcing strategies (CFS) | Cross-over study design; consecutive enrollment of 56 senior medical students during their emergency medicine rotation | McMaster University | Preliminary findings suggest that application of CFS and retention are poor. Even immediately after instruction, in a test situation that is deliberately linked to the educational intervention, fewer than half the students in the study used CFS to correctly “de-bias” themselves. Two weeks post-CFS training, there was no evidence of de-biasing. | Not provided | Moderate |
| **Sherbino et al., 201415** | A 90-minute, standardized, interactive, case-based teaching seminar on CFS | Prospective, controlled trial; 198 senior medical students in EM rotation (145 in intervention, 46 in control group) | McMaster University | The educational interventions employed to teach CFS failed to show any reduction in diagnostic error by novices. | Not provided | Low to moderate |
| **Smith et al., 200940** | Four-month online didactic continuing education program to improve ability of rural radiographers to interpret plain musculoskeletal radiographic examinations | Pre/post design, no comparison group; 16 rural radiographers | Northern Sector of the Hunter New England Area Health Service, UK | Short-term intensive training can improve diagnostic accuracy of rural radiographers. There was a statistically significant improvement at the “general opinion” and “observation” levels for the more complex cases (paired t-test, p<0.05), while there was no change in image interpretation accuracy for less complex cases. | Online educational intervention | Moderate |
| **Smith and Slack, 201516** | Workshop on debiasing (taught to recognize and respond to cognitive biases), including training reflective exercises | Pre/post study, no comparison group; 19 family medicine residents | Family Medicine Residency Program at David Grant Medical Center, Travis Air Force Base, California, United States | After the workshop, residents’ formulation of an acceptable plan to mitigate the effect of cognitive bias increased from 84% (36 of 43) to 100% (33 of 33, p=0.02). There was no effect on preceptor concurrence with the residents’ diagnoses, the residents’ ability to recognize their risk of cognitive bias, or the preceptors’ perception of an unrecognized cognitive bias in the residents’ presentation. | Not provided | Moderate |
| **Soh et al., 201334** | One-hour online e-learning tutorial to improve visual perception skills | Randomized controlled trial, 14 first-year medical radiation sciences students (technologists) | Medical radiation science program, Australia | The experiment group demonstrated a 45% increase in the mean number of fixations per case (p=.047), with a 30% increase in sensitivity (p=.022), following the tutorial. The experiment group also demonstrated improved lesion detection overall and a 49% decrease in mean time to first fixation on the lesion (p=.016). | Online educational intervention | Moderate |
| **van der Gijp et al., 201733** | Training on two visual search strategies, “scanning” and “drilling,” used in radiology to improve visual perception | Randomized cross-over design; 19 first- and second-year radiology residents | Academic medical center’s radiology residency program, United States | Perceptual performance following drilling search instructions outperformed performance following scanning search instruction in terms of true positives. | Not provided | Moderate |
| **Wolpaw et al., 20099** | Training on the use of SNAPPS technique—Summarize history and findings, Narrow the differential; Analyze the differential;  Probe preceptor about uncertainties;  Plan management; Select case-related issues for self-study—for case presentations to facilitate learning | Post-test-only, comparison groups, randomized trial; 108 third-year medical students | Case Western Reserve University School of Medicine, United States | SNAPPS group showed more diagnostic reasoning than a feedback comparison and a control group. | Not provided | Moderate (qualitative analysis) |