

APPENDIX

Contents:

- 1) Search strategy
- 2) Date extraction form
- 3) Quality Assessment Tools
- 4) Figure 1: Bar chart for categorization of articles containing diagnostic checklists based on SEIPS and their reported outcomes
- 5) Table 1: Quality and risk of bias assessment
- 6) Table 2: Checklists with physical “box checking” component
- 7) Table 3: List of checklists with examples of how their components fit into SEIPS categories

DIAGNOSTIC ERRORS & CHECKLISTS SEARCH STRATEGY (PAGES 1-2)

Search 1:

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All searches run from inception of database through 4/30/2019

No limits applied

PubMed (Medline + unindexed)

Embase.com

Scopus

Web of Science Core Collection

Total citations: 4812

Citations after Endnote automated deduplication: 2965 (removed 1847 duplicates)

1. PubMed (1691 on 4/30/2019)

("Checklist"[Mesh] OR checklist[tw] OR checklists[tw] OR "check list"[tw] OR "check lists"[tw] OR prechecklist*[tw] OR postchecklist*[tw] OR "Safety check"[tw] OR "safety checks"[tw] OR huddle[tw] OR pause*[tw] OR "universal protocol"[tw] OR "universal protocols"[tw] OR briefing[tw]) AND ("Diagnosis, Differential"[Mesh] OR "Diagnosis/adverse effects"[Mesh] OR (differential*[tw] AND diagnos*[tiab]) OR "Diagnostic Errors"[Mesh] OR "diagnostic error"[tw] OR "diagnostic errors"[tw] OR "wrong diagnosis"[tw] OR "false positive"[tw] OR "false negative"[tw] OR misdiagnose[tw] OR misdiagnosed[tw] OR misdiagnosis[tw] OR misdiagnoses[tw] OR misdiagnosing[tw])

2. Embase (1153 on 4/30/2019)

('Checklist'/exp OR checklist:ti,ab,de,tn OR checklists:ti,ab,de,tn OR "check list":ti,ab,de,tn OR "check lists":ti,ab,de,tn OR prechecklist*:ti,ab,de,tn OR postchecklist*:ti,ab,de,tn OR "Safety check":ti,ab,de,tn OR "safety checks":ti,ab,de,tn OR huddle:ti,ab,de,tn OR pause*:ti,ab,de,tn OR "universal protocol":ti,ab,de,tn OR "universal protocols":ti,ab,de,tn OR briefing:ti,ab,de,tn) AND ('Differential Diagnosis'/exp OR (differential*:ti,ab AND diagnos*:ti,ab) OR 'Diagnostic Error'/exp OR "diagnostic error":ti,ab,de,tn OR "diagnostic errors":ti,ab,de,tn OR "wrong diagnosis":ti,ab,de,tn OR "false positive":ti,ab,de,tn OR "false negative":ti,ab,de,tn OR misdiagnose:ti,ab,de,tn OR misdiagnosed:ti,ab,de,tn OR misdiagnosis:ti,ab,de,tn OR misdiagnoses:ti,ab,de,tn OR misdiagnosing:ti,ab,de,tn)

3. Scopus (1384 on 4/30/2019)

(INDEXTERMS(Checklist) OR TITLE-ABS-KEY(checklist) OR TITLE-ABS-KEY(checklists) OR TITLE-ABS-KEY({check list}) OR TITLE-ABS-KEY({check lists}) OR TITLE-ABS-KEY({check-list}) OR TITLE-ABS-KEY({check-lists}) OR TITLE-ABS-KEY(prechecklist*) OR TITLE-ABS-KEY(postchecklist*) OR TITLE-ABS-KEY({Safety check}) OR TITLE-ABS-KEY({safety checks}) OR TITLE-ABS-KEY(huddle) OR TITLE-ABS-KEY(pause*) OR TITLE-ABS-KEY({universal protocol}) OR TITLE-ABS-KEY({universal protocols}) OR TITLE-ABS-

KEY(briefing)) AND (INDEXTERMS({Diagnosis, Differential}) OR INDEXTERMS({Diagnosis/adverse effects}) OR (TITLE-ABS-KEY(differential*) AND TITLE-ABS(diagnos*)) OR INDEXTERMS({Diagnostic Errors}) OR TITLE-ABS-KEY({diagnostic error}) OR TITLE-ABS-KEY({diagnostic errors}) OR TITLE-ABS-KEY({wrong diagnosis}) OR TITLE-ABS-KEY({false positive}) OR TITLE-ABS-KEY({false negative}) OR TITLE-ABS-KEY(misdiagnose) OR TITLE-ABS-KEY(misdiagnosed) OR TITLE-ABS-KEY(misdiagnosis) OR TITLE-ABS-KEY(misdiagnoses) OR TITLE-ABS-KEY(misdiagnosing))

4. **Web of Science Core Collection (584 on 4/30/2019)**

TS=(checklist* OR "check list" OR "check lists" OR "check-list" OR "check-lists" OR prechecklist* OR postchecklist* OR "Safety check" OR "safety checks" OR "huddle" OR pause* OR "universal protocol" OR "universal protocols" OR "briefing") AND ("Diagnosis, Differential" OR "Diagnosis/adverse effects" OR (differential* AND diagnos*) OR "diagnostic error" OR "diagnostic errors" OR "wrong diagnosis" OR "false positive" OR "false negative" OR misdiagnose OR misdiagnosed OR misdiagnosis OR misdiagnoses OR misdiagnosing)

Search 2:

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All searches run from 05/01/2019-03/12/2021

Total Citations: 575 (total before deduplication)

Citations after Covidence automated deduplication: 332 (removed 243 duplicates)

Pubmed (150 results)

[Prior Search] AND (("2019/05/01"[CRDT] : "3000"[CRDT]) OR ("2019/05/01"[EDAT] : "3000"[EDAT]) OR ("2019/05/01"[MHDA] : "3000"[MHDA]))

Embase.com (217 results)

[Prior Search] AND [1-5-2019]/sd NOT [13-3-2021]/sd

Scopus (116 results)

[Prior Search] AND (ORIG-LOAD-DATE > 20190501)

Web of Science (92 results)

[Prior Search] AND (LD=(2019-05-01/2021-03-12))

Search 3:

February 15, 2022 Search Update

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All searches re-run and deduplicated against prior results sets. Numbers indicate new citations after deduplication.

Total New Unique Citations: 247

Pubmed (1902 results; 96 unique results)

Embase.com (1476 results; 80 unique results)

Scopus (1610 results; 32 unique results)

Web of Science (773 results; 39 unique results)

Total: 5761 results, 3444 after deduplication in Endnote

- PubMed: 1902, 1902 after deduplication
- Embase.com: 1476, 901 after deduplication
- Scopus: 1610, 399 after deduplication
- Web of Science: 773, 302 after deduplication

***Further deduplication with Covidence resulted in 3186 articles and a total of 2575 duplicates.**

DATA EXTRACTION FORM (ADOPTED FROM COCHRANE; PAGES 3-6)

Title of the Systematic Review: CHECKLISTS TO REDUCE DIAGNOSTIC ERROR: A SYSTEMATIC REVIEW OF THE LITERATURE USING A HUMAN FACTORS FRAMEWORK

General Information

2. Article title	
3. Study ID (1 st author's last name and year)	
4. Domain (i.e. diagnostic error)	
5. Study Design (i.e. RCT, Case-Control, Cohort, Observational)	
6. Population Description (i.e. M4s, Residents, PCPs, EM physicians, etc. Also include number of participants, total, and how many in each study arm i.e. control arm, intervention, arm, RCT arms)	
7. Intervention Type (i.e. debiasing or ddx checklist, also algorithm or flow diagram)	
Intervention Description (i.e. checklist on EKGs ddx, chest pain ddx, etc. Also describe how was the intervention rolled out)	
Study setting (i.e. simulation lab, primary care clinics, ERs)	
8. Primary Outcome Description	
9. Secondary Outcome Description	
10. Impact on Outcomes (including statistical significance)	
Notes:	

Checklists Content Categories Based on SEIPS 2.0*

Checklist	Sociotechnical Work System (i.e. person(s), tasks, tools and technologies, organization, internal environment, and external environment)	Processes (i.e. physical, cognitive, and social/behavioral <i>performance</i> processes)	Outcomes (i.e. patient, professional, and organizational outcomes)

*Created by the authors, who have the permission to reuse the table.

IF checklist is “Cognitive”, then further describe*:

Checklist	Does the checklist specifically point out urgent/emergent conditions (if so, specify if prioritized)?	Does the checklist include a list differential diagnosis?	Does the checklist have other components (aside from ddx) such as exam or history or tests (if so, specify)?	Does the checklist specifically point out “common pitfalls/biases”?

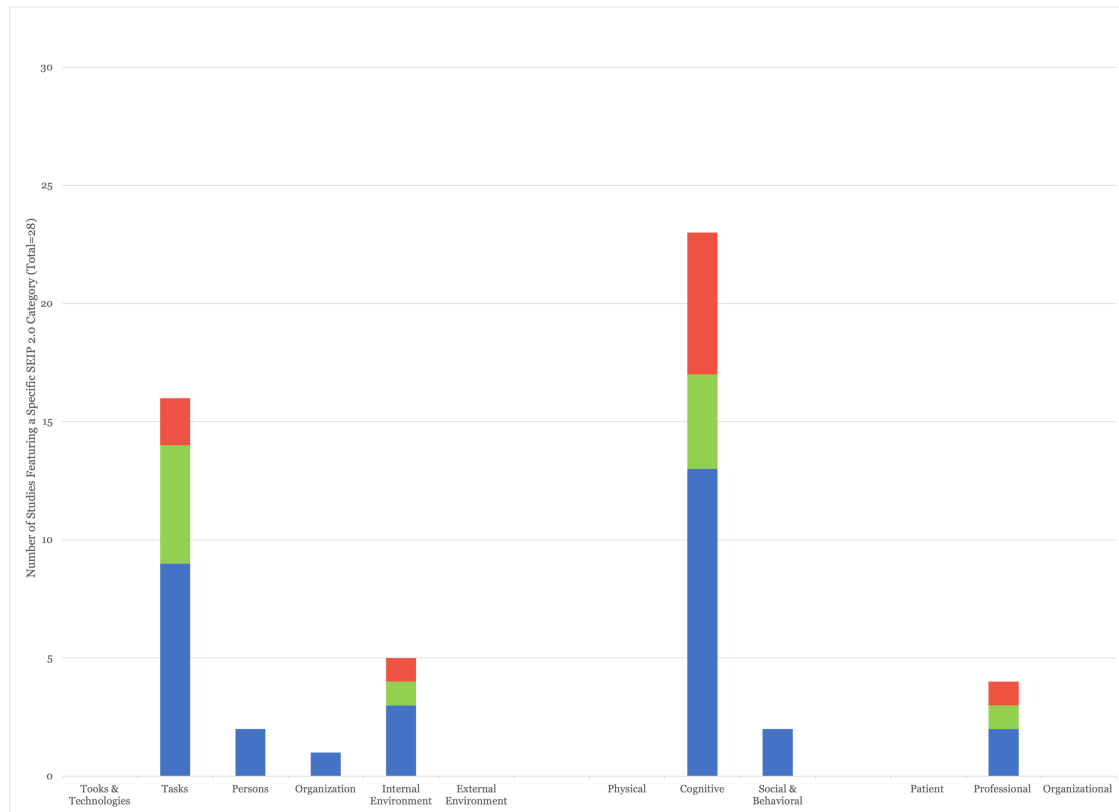
*Created by the authors, who have the permission to reuse the table.

Checklists in article:

Quality Assessment Tools:

- Cochrane's Risk of Bias (RoB) 2.0 tool: <https://methods.cochrane.org/bias/resources/rob-2-revised-cochrane-risk-bias-tool-randomized-trials>
- Risk Of Bias In Non-randomized Studies of Interventions (ROBINS-I) tool: <https://methods.cochrane.org/methods-cochrane/robins-i-tool>
- Newcastle-Ottawa Scale for Cohort Studies: http://www.ohri.ca/programs/clinical_epidemiology/nosgen.pdf
- NIH Quality Assessment Tool for Pre-Posttest Studies: <https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools>

Figure 1^{*}: Categorization of articles containing diagnostic checklists based on SEIPS 2.0 and their reported outcomes



^{*}Created by the authors, who have the permission to reuse the figure.

*Blue: opinion-based articles containing clinical diagnosis checklists or studies reporting results on user perception.

*Green: studies containing checklists that showed improvement in reducing diagnostic error.

*Red: studies containing checklists that didn't show improvement in reducing diagnostic error.

Table 1* : Quality and Risk of Bias Assessment

Study ID	Study Design	Checklist	Quality Assessment
Ely 2015	RCT	Ely's DDx checklists	(RoB 2.0) Some concerns
Nickerson 2019	RCT	ECG syncope checklist	(RoB 2.0) Low risk
O'Sullivan 2019	RCT	Mnemonic tool (SLOW) ^a	(RoB 2.0) Some concerns
Sibbald 2019	RCT	General debiasing checklist (Ely 2011)	(RoB 2.0) Some concerns
		ECG interpretation checklist	
Kok 2017	RCT	Chest radiograph interpretation checklist	(RoB 2.0) Low risk
Sibbald 2015	RCT	ECG interpretation checklist	(RoB 2.0) Low risk
Chew 2016	Quasi-experimental	Mnemonic tool (TWED) ^b	(ROBINS-I) Low risk
Chew 2017	Quasi-experimental	Mnemonic tool (TWED)	(ROBINS-I) Low risk
Sibbald 2013 ⁴⁵	Pre-Posttest (no control)	ECG interpretation checklist	(NIH) Fair
Sibbald 2013 ⁴⁶	Pre-Posttest (no control)	Checklist for cardiac exam	(NIH) Good
Sibbald 2014	Pre-Posttest (no control)	ECG interpretation checklist	(NIH) Good
Kilian 2019	Pre-Posttest (no control)	Mnemonic tool (ACT) ^c	(NIH) Poor
Shimizu 2013	Pre-Posttest (two study groups, no control)	General debiasing checklist (Ely 2011)	(NIH) Fair
		Symptom-specific DDx checklist (similar to Ely's 2011 DDx checklists)	
Pan 2021	Retrospective Cohort	Abdominal pain checklist	(NOS) Good quality

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^a SLOW: S=Sure about that?; L=Look at date, what is Lacking?; O=What if Opposite is true?; S=Worst case scenario

^b TWED: T=Threat, W=What else, E=Evidence and D=Dispositional factors

^c ACT: three questions evaluating A=Alternatives, C=Consequences, T=Traits

Table 2*: Checklists with Physical “Box Checking” Component^a

Study ID	Study Design	Checklist	Work Systems	Processes	Outcomes
O’Sullivan 2019	RCT	Mnemonic (SLOW) meant to slow down reasoning and counter bias		Cognitive	
Ely 2016	Expert opinion	General checklist for mental pause	Internal environment, Tasks, Organization, Persons	Cognitive	Professional
Graber 2014	Pre and posttest (interviews/user perception)	Checklist for high-risk diagnostic error	Persons	Cognitive	
Huang 2017	Pre and posttest, focus groups, chart audits	Diagnostic pause tool	Tasks	Cognitive	
Nedorost 2018	Observational and survey	Dermatitis checklist	Tasks	Social and Behavioral	

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^aStudies of checklists that reported on whether a checklist reduced diagnostic error (orange shade) vs those that reported expert opinion or user perception (gray shade)

Table 3* : List of Checklists

Study ID	Checklist	URL	Work Systems	Processes	Outcomes
Bahrami 2009	Radiology interpretation checklist for brain	https://pubs.rsna.org/cms/10.1148/rg.297095123/asset/images/large/g09nv14t02x.jpeg	Tasks (e.g., take “clinical history” and check “sulci”)		
Bello 2019	Radiology interpretation checklist for skull base	https://pubs.rsna.org/cms/10.1148/rg.2019180118/asset/images/large/rg.2019180118.tb11.jpeg	Tasks (e.g., “Anterior: Look for fractures”)		
Chew 2016	Mnemonic tool (TWED) ^b meant to facilitate metacognition	http://www.smj.org.sg/sites/default/files/SMJ-57-694-g002.jpg	Internal environment (e.g., “chaotic, busy working place”)	Cognitive (e.g., “what if I’m wrong? What else could it be?”)	Professional (e.g., “emotional – sleepiness, tiredness”)
Ely 2011	General debiasing checklist	https://images.journals.lww.com/academicmedicine/ArticleViewerPreview.0001888-201103000-00017.T2-17.jpeg	Tasks (e.g., “ensure a pathway for follow-up”)	Cognitive (e.g., “Was my judgement affected by any other bias?”)	
	Ely’s differential diagnosis (DDx) checklists	https://images.journals.lww.com/academicmedicine/ArticleViewerPreview.0001888-201103000-00017.T3-17.jpeg		Cognitive (e.g., “Sinus tachycardia” listing ddx as “anxiety” and “myocardial infarction”)	
	Disease-specific cognitive forcing checklist	https://images.journals.lww.com/academicmedicine/ArticleViewerPreview.0001888-201103000-00017.T4-17.jpeg	Tasks (e.g., perform “anterior drawer test”)	Cognitive (e.g., listing pitfalls for ankle injury, such as “missed neurovascular injury”)	
Ely 2016	General checklist for mental pause	https://www.aafp.org/afp/2016/0915/hires/afp20160915p426-t1.gif	Internal environment (e.g., “distracted”), Tasks (e.g., “take the history, do the physical exam”), Organization (e.g., “time pressure (behind schedule)”), Persons (e.g., “patient drunk or hostile”)	Cognitive (e.g., “Did I just accept the first diagnosis that came to mind without considering other possibilities?”)	Professional (e.g., “physician fatigued” or “angry”)
Graber 2014	Checklist for high-risk diagnostic error	https://www.degruyter.com/document/doi/10.1515/dx-2014-0019/asset/graphic/dx-2014-0019_fig2.jpg	Internal environment (e.g., “was I interrupted/distracted”), Persons (e.g., “is this a patient I don’t like for some reason? Or like too much?”)	Cognitive (e.g., “Are there any pieces that don’t fit?”)	
Hess 2008	Lower extremity ulcer checklist	https://images.journals.lww.com/aswcjournal/Original.00129334-201010000-00012.TU1-12.jpeg		Cognitive (e.g., “Infectious disorders” with ddx listed as “Bacterial... Fungal... Parasitic”)	
Huang 2017	Diagnostic pause tool	https://qualitysafety.bmj.com/content/27/6/492.full	Tasks (e.g., “Make a medication change”)	Cognitive (e.g., “What features of the case go against this diagnosis?”)	
Kilian 2019	Mnemonic tool (ACT) ^c meant to elicit diagnostic reflection	https://www.degruyter.com/document/doi/10.1515/dx-2018-0073/html		Cognitive (e.g., “Is there contradictory evidence?”)	
Kok 2017	Chest radiograph interpretation checklist	https://link.springer.com/article/10.1007/s10278-017-9979-0/tables/1	Tasks (e.g., check “Heart-large vessels” and “Trachea”)	Cognitive (e.g., lists potential pitfalls such as “Wrong patient” and “Wrong data”).	
Li 2022	Checklist of causes of abdominal pain	https://www.sciencedirect.com/science/article/pii/S1015958421007077?via%3Dihub#tbl1		Cognitive (e.g., list of “common diseases” classified under the “acute inflammatory”)	

				category)
Nedorost 2018	Dermatitis checklist	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6217130/table/t1-ccid-11-545/?report=objectonly	Tasks (e.g., “Examine for signs of (often amyopathic) dermatomyositis”)	Social and Behavioral (e.g., “Framing communication”)
Nickerson 2019	Electrocardiogram (ECG) syncope checklist	https://www.sciencedirect.com/science/article/abs/pii/S0735675719302141?via%3Dihub		Cognitive (e.g., “Below is a list of conditions that may cause syncope”)
Nordick 2020	DaRT – Diagnostic and Reasoning Tool	https://journals.lww.com/janp/Abstract/2021/05000/Integrating_strategies_for_improving_diagnostic.7.aspx	Tasks (e.g., “Patient encounter” includes “History of Present Illness” and Physical Exam”)	Cognitive (e.g., “What are the initial possible diagnoses?”)
O’Sullivan 2018	Debiasing checklist	https://www.rcpe.ac.uk/sites/default/files/jrcpe_48_3_osullivan.pdf		Cognitive (e.g., “Be aware of base rates for your differentials”)
O’Sullivan 2019	Mnemonic tool (SLOW) ⁴ meant to slow down reasoning and counter bias	https://media.springernature.com/lw685/springer-static/image/art%3A10.1186%2Fs12909-018-1444-3/MediaObjects/12909_2018_1444_Fig1_HTML.png?as=webp		Cognitive (e.g., “What if the opposite is true?”)
Pan 2021	Abdominal pain checklist and algorithm	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7924112/table/t0001/?report=objectonly		Cognitive (e.g., Causes of “Abdominal pain” including “Anatomical Localization,” “Category of Etiology” and “Acute Common Disease”)
Rush 2017	Mnemonic tool (CARE) ⁶ meant to counter bias	https://onlinelibrary.wiley.com/doi/10.1111/ijd.13532	Tasks (e.g., “Enact a plan”)	Cognitive (e.g., “Assess for biases”), Social and Behavioral (e.g., “Communicate with your team and patient”)
Shimizu 2013	Symptom-specific DDX checklist (similar to Ely’s 2011 DDX checklists)	https://www.tandfonline.com/doi/full/10.3109/0142159X.2012.742493		Cognitive (e.g., “Epigastralgia” causes listed including “gastritis” and “esophageal rupture”)
Sibbald 2013 ⁴⁸	ECG interpretation checklist	https://onlinelibrary.wiley.com/doi/10.1111/medu.12080	Tasks (e.g., “calculate the rate” and “scan the entire strip to confirm the rhythm”)	
Sibbald 2013 ⁴⁹	Checklist for cardiac exam	https://qualitysafety.bmj.com/content/22/4/333	Tasks (e.g., fill in descriptors for cardiovascular exam including “carotid,” “JVD,” “S1,” and “S2”)	
Weber 1997	Checklist for orbital and periorbital swelling	https://www.tandfonline.com/doi/abs/10.3109/01676839709076362		Cognitive (e.g., Periorbital “Itching” includes the differentials of “Contact allergy” and “Atopic dermatitis”)
Yung 1983	Flowchart	https://www.sciencedirect.com/science/article/abs/pii/036192308390182X?via%3Dihub	Tasks (e.g., Perform “Medical History” and “Ask drug use”)	Cognitive (e.g., “Psychiatric conditions” include “Anxiety tremor” and “Hysteria”)

⁶Created by the authors, who have the permission to reuse the table.