APPENDIX 1. SEARCH STRATEGIES

1.1 OVID MEDLINE AND EMBASE

1	(scrib* and (throughput or productivity or quality or errors or satisfaction or attitude or interaction or RVU or contact time or revenue or cost or turnover)).ti,ab.	786
2	(scrib* or transcriber* or documentation assistant*).mp.	4066
3	(emr or ehr or "medical record*" or "health record*").mp.	628093
4	exp medical records systems, computerized/ or electronic health records/	53008
5	2 and (3 or 4)	316
6	1 or 5	942
7	Limit 6 to English language	914
8	limit 7 to yr="2010 -Current"	754
9	remove duplicates from 8	537

1.2 CINAHL

1	TI (scrib* and (throughput or productivity or quality or errors or satisfaction or attitude or interaction or RVU or contact time or revenue or cost or turnover) OR AB (scrib* and (throughput or productivity or quality or errors or satisfaction or attitude or interaction or RVU or contact time or revenue or cost or turnover)	119
2	TI (scrib* or transcriber* or documentation assistant*) OR AB (scrib* or transcriber* or documentation assistant*)	475
3	MW ((emr or ehr or "medical record*" or "health record*"or medical records systems, computerized/ or electronic health records/)	42181
4	2 and 3	57
5	1 or 4	155

APPENDIX 2. STUDY SELECTION

	Inclusion Criteria		Exclusion Criteria
Population	Adult patients and/or practitioners in cardiology, orthopedic or emergency department clinics EXCEPTION: Study done in within VA, even if it is primary care or another specialty		Must be medical clinic (exclude OR, cardiac cath or laboratory settings) Exclude studies in trauma service settings Exclude Primary care clinics (please tag) Exclude studies involving only children or pediatric clinics; studies including adults and children must stratify results based on age
Intervention	"Medical scribe" or document assistant program that involves navigation of electronic health record system (must provide some information about scribe responsibilities/duties).		"Medical scribe" or "documentation assistant" programs that don't involve an electronic medical record system Medical transcriptionist or documentation assistant programs that work remotely or transcribe based on physician recordings
Comparator	Any		Studies without a comparison
Outcomes	Primary: Clinic efficiency (as measured by): # patients seen per day time to consult time to appt appointment length ED waiting times time in ED (time to hospital admission or discharge to home) left without being seen in ED	Secondary: Patient satisfaction Practitioner satisfaction Quality of documentation Cost (expenses [scribe-related costs] and revenues [RVU, *etc*]) Time needed to train scribes Scribe turnover Medical errors	
Timing	Any		Published prior to 2010
Setting	Any location (to include government, private, university-affiliated, and VA facilities worldwide)		

ED=emergency department; OR=operating room; RVU=relative value units

APPENDIX 3. QUALITY ASSESSMENT CRITERIA

3.1 RISK OF BIAS IN NON-RANDOMIZED STUDIES – OF INTERVENTIONS (ROBINS-I)[13]

Bias due to confounding			
Low	**Moderate**	**Serious**	**Critical**
(the study is comparable to a well-preformed randomized trial with regard to this domain) No confounding expected.	(the study is sound for a nonrandomized study with regard to this domain but cannot be considered comparable to a well-performed randomized trial) (i) Confounding expected, all known important confounding domains appropriately measured and controlled for; *and* (ii) Reliability and validity of measurement of important domains were sufficient, such that we do not expect serious residual confounding.	(the study has some important problems) (i) At least one known important domain was not appropriately measured, or not controlled for; *or* (ii) Reliability or validity of measurement of an important domain was low enough that we expect serious residual confounding.	(the study is too problematic to provide any useful evidence on the effects of intervention) (i) Confounding inherently not controllable *or* (ii) The use of negative controls strongly suggests unmeasured confounding.
Bias in selection of participants into study			
Low	**Moderate**	**Serious**	**Critical**
(the study is comparable to a well-preformed randomized trial with regard to this domain) (i) All participants who would have been eligible for the target trial were included in the study; *and* (ii) For each participant, start of follow up and start of intervention coincided.	(the study is sound for a nonrandomized study with regard to this domain but cannot be considered comparable to a well-performed randomized trial) (i) Selection into the study may have been related to intervention and outcome; and the authors used appropriate methods to adjust for the selection bias; *or* (ii) Start of follow-up and start of intervention do not coincide for all participants; *and* (a) the proportion of participants for which this was the case was too low to induce important bias; *or* (b) the authors used appropriate methods to adjust for the selection bias; *or*	(the study has some important problems) (i) Selection into the study was related (but not very strongly) to intervention and outcome; *and* This could not be adjusted for in analyses; *or* (ii) Start of follow up and start of intervention do not coincide; *and* A potentially important amount of follow-up time is missing from analyses; and the rate ratio is not constant over time.	(the study is too problematic to provide any useful evidence on the effects of intervention) (i) Selection into the study was very strongly related to intervention and outcome; *and* This could not be adjusted for in analyses; *or* (ii) A substantial amount of follow-up time is likely to be missing from analyses; *and* the rate ratio is not constant over time.

	(c) the review authors are confident that the rate (hazard) ratio for the effect of intervention remains constant over time.		
Bias in classification of interventions			
Low	**Moderate**	**Serious**	**Critical**
(the study is comparable to a well-preformed randomized trial with regard to this domain) (i) intervention status is well defined; *and* (ii) Intervention definition is based solely on information collected at the time of intervention.	(the study is sound for a nonrandomized study with regard to this domain but cannot be considered comparable to a well-performed randomized trial) (i) Intervention status is well defined; *and* (ii) Some aspects of the assignments of intervention status were determined retrospectively.	(the study has some important problems) (i) Intervention status is not well defined; *or* (ii) Major aspects of the assignments of intervention status were determined in a way that could have been affected by knowledge of the outcome.	(the study is too problematic to provide any useful evidence on the effects of intervention) (Unusual) An extremely high amount of misclassification of intervention status, e.g. because of unusually strong recall biases.
Bias due to deviations from intended intervention			
Low	**Moderate**	**Serious**	**Critical**
(the study is comparable to a well-preformed randomized trial with regard to this domain) Effect of assignment to intervention: (i) Any deviations from intended intervention reflected usual practice; *or* (ii) Any deviations from usual practice were unlikely to impact on the outcome. Effect of starting and adhering to intervention: The important co-interventions were balanced across intervention groups, and there were no deviations from the intended interventions (in terms of implementation or adherence) that were likely to impact on the outcome.	(the study is sound for a nonrandomized study with regard to this domain but cannot be considered comparable to a well-performed randomized trial) Effect of assignment to intervention: There were deviations from usual practice, but their impact on the outcome is expected to be slight. Effect of starting and adhering to intervention: (i) There were deviations from intended intervention, but their impact on the outcome is expected to be slight. *or* (ii) The important co-interventions were not balanced across intervention groups, or there were deviations from the intended interventions (in terms of implementation and/or adherence) that were likely to impact on the outcome; *and* The analysis was appropriate to estimate the effect of starting and adhering to intervention, allowing for deviations (in terms of implementation, adherence and co-	(the study has some important problems) Effect of assignment to intervention: There were deviations from usual practice that were unbalanced between the intervention groups and likely to have affected the outcome. Effect of starting and adhering to intervention: (i) The important co-interventions were not balanced across intervention groups, or there were deviations from the intended interventions (in terms of implementation and/or adherence) that were likely to impact on the outcome; *and* (ii) The analysis was not appropriate to estimate the effect of starting and adhering to intervention, allowing for deviations (in terms of implementation, adherence and cointervention) that were likely to impact on the outcome.	(the study is too problematic to provide any useful evidence on the effects of intervention) Effect of assignment to intervention: There were substantial deviations from usual practice that were unbalanced between the intervention groups and likely to have affected the outcome. Effect of starting and adhering to intervention: (i) There were substantial imbalances in important cointerventions across intervention groups, or there were substantial deviations from the intended interventions (in terms of implementation and/or adherence) that were likely to impact on the outcome; *and* (ii) The analysis was not appropriate to estimate the effect of starting and adhering to intervention, allowing for deviations (in terms of implementation, adherence and cointervention) that were likely to impact on the outcome.

	intervention) that were likely to impact on the outcome.		

Bias due to missing data

Low	Moderate	Serious	Critical
(the study is comparable to a well-preformed randomized trial with regard to this domain) (i) Data were reasonably complete; *or* (ii) Proportions of and reasons for missing participants were similar across intervention groups; *or* (iii) The analysis addressed missing data and is likely to have removed any risk of bias.	(the study is sound for a nonrandomized study with regard to this domain but cannot be considered comparable to a well-performed randomized trial) (i) Proportions of and reasons for missing participants differ slightly across intervention groups; *and* (ii) The analysis is unlikely to have removed the risk of bias arising from the missing data.	(the study has some important problems) (i) Proportions of missing participants differ substantially across interventions; *or* Reasons for missingness differ substantially across interventions; *and* (ii) The analysis is unlikely to have removed the risk of bias arising from the missing data; *or* Missing data were addressed inappropriately in the analysis; *or* the nature of the missing data means that the risk of bias cannot be removed through appropriate analysis.	(the study is too problematic to provide any useful evidence on the effects of intervention) (i) (Unusual) There were critical differences between interventions in participants with missing data; *and* (ii) Missing data were not, or could not, be addressed through appropriate analysis.

Bias in measurement of outcomes

Low	Moderate	Serious	Critical
(the study is comparable to a well-preformed randomized trial with regard to this domain) (i) The methods of outcome assessment were comparable across intervention groups; *and* (ii) The outcome measure was unlikely to be influenced by knowledge of the intervention received by study participants (i.e. is objective) or the outcome assessors were unaware of the intervention received by study participants; *and* (iii) Any error in measuring the outcome is unrelated to intervention status.	(the study is sound for a nonrandomized study with regard to this domain but cannot be considered comparable to a well-performed randomized trial) (i) The methods of outcome assessment were comparable across intervention groups; *and* (ii) The outcome measure is only minimally influenced by knowledge of the intervention received by study participants; *and* (iii) Any error in measuring the outcome is only minimally related to intervention status.	(the study has some important problems) (i) The methods of outcome assessment were not comparable across intervention groups; *or* (ii) The outcome measure was subjective (i.e. vulnerable to influence by knowledge of the intervention received by study participants); *and* the outcome was assessed by assessors aware of the intervention received by study participants; *or* (iii) Error in measuring the outcome was related to intervention status.	(the study is too problematic to provide any useful evidence on the effects of intervention) The methods of outcome assessment were so different that they cannot reasonably be compared across intervention groups.

Bias in selection of the reported result

Low	Moderate	Serious	Critical
(the study is comparable to a well-preformed randomized trial with regard to this domain)	(the study is sound for a nonrandomized study with regard to this domain but cannot	(the study has some important problems)	(the study is too problematic to provide any useful evidence on the effects of intervention)

There is clear evidence (usually through examination of a pre-registered protocol or statistical analysis plan) that all reported results correspond to all intended outcomes, analyses and subcohorts.	be considered comparable to a well-performed randomized trial) (i) The outcome measurements and analyses are consistent with an a priori plan; *or* are clearly defined and both internally and externally consistent; *and* (ii) There is no indication of selection of the reported analysis from among multiple analyses; *and* (iii) There is no indication of selection of the cohort or subgroups for analysis and reporting on the basis of the results.	(i) Outcomes are defined in different ways in the methods and results sections, or in different publications of the study; *or* (ii) There is a high risk of selective reporting from among multiple analyses; *or* (iii) The cohort or subgroup is selected from a larger study for analysis and appears to be reported on the basis of the results.	(i) There is evidence or strong suspicion of selective reporting of results; *and* (ii) The unreported results are likely to be substantially different from the reported results.

3.2 COCHRANE RISK OF BIAS ASSESSMENT[14]

Domains	Low	Unclear	High
Randomization generation Allocation concealment Blinding of participants and personnel Blinding of outcome assessors Incomplete outcome data Selective reporting	Plausible bias unlikely to seriously alter the results.	Plausible bias that raises some doubt about the results.	Plausible bias that seriously weakens confidence in the result

APPENDIX 4. QUALITY ASSESSMENT FOR ELIGIBLE PUBLICATIONS

4.1 NON-RANDOMIZED STUDIES

Author, Year	Bias due to confounding	Bias in selection of participants	Bias in classification of interventions	Bias due to deviations for intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall
Allen, 2014[42]	Serious	Serious	Low	No information	Serious	Moderate	Moderate	Serious
Arya, 2010[43]	Moderate	Moderate	Moderate	Moderate	Low	Low	Moderate	Moderate
Bank, 2013[28]	Moderate	Critical	Moderate	Moderate	Moderate	Low	Low	Critical
Bank, 2015[29]	Serious	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Serious
Bastani, 2014[44]	Serious	Serious	Moderate	No information	No information	Moderate	Moderate	Serious
Dunlop, 2018[34]	Serious	Moderate	Low	Low	Low	Low	Low	Serious
Graves, 2018[46]	Serious	Moderate	Low	Low	Low	Low	Low	Serious
Heaton, 2016[36]	Serious	Low	Low	Low	Low	Moderate	Moderate	Serious
Heaton, 2017a[37]	Serious	Low	Low	No information	Low	Moderate	Moderate	Serious
Heaton, 2017b[38]	Moderate	Low	Low	Low	Low	Low	Low	Moderate
Heaton, 2018[39]	Serious	Moderate	Low	No information	No information	Serious	Moderate	Serious
Heaton, 2019a[41]	Serious	Moderate	Low	No information	Low	Low	Moderate	Serious
Heaton, 2019b[40]	Serious	Moderate	Low	No information	No information	Low	Moderate	Serious
Hess, 2015[47]	Serious	Serious	Low	No information	Serious	Moderate	Moderate	Serious
Ou, 2017[48]	Serious	Serious	Low	No information	No information	Serious	Moderate	Serious
Shuaib, 2017[49]	Serious	Moderate	Moderate	Moderate	No information	Moderate	Moderate	Serious
Walker, 2014[30]	Critical	Critical	Moderate	Moderate	Moderate	Moderate	Moderate	Critical
Walker, 2016a[31]	Serious	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Serious
Walker, 2016b[32]	Serious	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Serious
Walker, 2017[33]	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Moderate

4.2 RANDOMIZED CONTROLLED TRIALS

Author, Year	Random Sequence generation:	Allocation concealment	Blinding of personnel and participants:	Blinding of outcome assessment:	Incomplete outcome data	Selective outcome reporting	Other	Overall
Friedson, 2018[45]	Low	Unclear	High	Low	Low	Low	None	Moderate
Walker, 2019[35]	Low	Low	High	Low	Low	Low	None	Moderate

APPENDIX 5. PEER REVIEW COMMENTS/AUTHOR RESPONSES

Question	Reviewer Number	Comment	Author Response
Are the objectives, scope, and methods for this review clearly described?	1	Yes	Thank you.
	2	Yes	
	3	Yes	
	4	Yes	
Is there any indication of bias in our synthesis of the evidence?	1	No	Thank you.
	2	No	
	3	No	
	4	No	
Are there any published or unpublished studies that we may have overlooked?	1	No	Thank you.
	2	No	
	3	No	
	4	No	
Additional suggestions or comments can be provided below. If applicable, please indicate the page and line numbers from the draft report.	1	Nice job on this! The executive summary could use another round of proofreading.	Thank you for the comment, we have proofread the executive summary and made edits as necessary.
	2	Suggested changes, subtle and at the authors discretion. Page 2, line 50: Data was not pooled; rather narratively synthesized. Page 3, line 32: Are the quotations necessary? Page 3, line 41: Take out and and make separate sentence thereafter. Feels run on. Page 3, line 45: KQ1 not previously defined and never is. Needs to be now or before introducing.	Thank you for the suggestions, edits have been made as appropriate. The Key Questions are initially introduced at the end of the introduction on page 1-2.
	4	Recommended edits: p. ii, line 36- correct credentials, Storm Morgan, MSN, MBA, RN p. 4, line 30- "in" appears to be an extra word p.5, line 24 and p.42, line 14-15. Word through put should be one word p. 8, line 9-10- nurse practitioners are a form of advanced practice nurses so listing both entries seems unusual. I expected to see physicians, nurse practitioners, and physician assistants. p. 34, line 8-9- Is the forward slash correct for 7.61/(456.6 mins)?	Thank you for the suggestions, edits have been made as appropriate.

APPENDIX 6. EVIDENCE TABLES

Appendix Table 6-1. Characteristics of Cardiology Studies

Author, year Study Design Funding Source Risk of Bias Study Period	Description of Study	Scribe Training/Experience Scribe Duties	Patient Baseline Measures		Primary Objective Outcomes
			Scribe	**Non-scribe**	
Bank, 2015[29] Retrospective observational Funding NR Serious ROB 2014	Ten cardiologists who used scribes were compared to 15 cardiologists who did not over a 1-year period in a single center clinic. Sixteen scribes helped the 10 cardiologists, some were paired with a physician, but many physicians worked with several different scribes over the year. All patient clinic visits were tracked. Patients seen at outreach sites, in device clinic, or in urgent care clinic were not included. For physicians without scribes, patients were scheduled 20 minutes for follow-up and 40 minutes for new patient visits. Every 4 hours, one follow-up slot was left unscheduled for physicians to "catch up" with dictation/documentation. For physicians using scribes, the open 20-minute slot every 4 hours was eliminated; resulting in 22 and 24 scheduled patients per 8-hour day, respectively. Revenue was tracked on new and follow-up patients to estimate revenues.	**Scribe training:** Scribes provided by vendor service with 6 years' experience; 184 hours total training, including terminology, classroom lecture, on-floor training, supervised scribing and reviews with supervisor Cardiology-specific training included terminology, review of templates and clinic processes, shadowing a scribe and review of common cardiology diagnoses **Scribe duties:** Reviewed charts prior to clinic visits, generated preliminary notes using a template provided by each physician, recorded historical information during clinic visits, transcribed information provided by the physician after clinic visits, and completed scheduling, billing, patient instruction, and after-visit summary forms under the direction of the physician.	NR	NR	**Physician productivity** • Patients per hour • Patients seen per year per physician • Average direct revenue • Downstream revenue

Abbreviations: NR=not reported; ROB=risk of bias

Appendix Table 6-2. Reported Outcomes from Cardiology Studies

Author, year Study design	Clinic Efficiency		Financial Productivity	Relative Value Units	Quality of Documentation
	Scribe (n=10)	Non-scribe (n=15)			
Bank, 2015[29] Retrospective observational	**New patients seen per year** N=955 New patients per year per provider: 955/10=95.5 **Follow-up patients seen per year** N=4830 Follow-up patients per year per provider: 4830/10=483 **Patients/hour** 2.50 +/-0.27 P=0.01 9.6% more patients/hour (increased productivity)	**New patients seen per year** N=1318 New patients per year per provider: 1318/15=87.9 **Follow-up patients seen per year** N=7150 Follow-up patients per year per provider: 7150/15=476 **Patients/hour** 2.28 +/-0.15	"The use of scribes resulted in …an additional annual revenue of $1,372,694 at a cost [for the scribes] of $98,588." "Physicians with scribes also generated an additional revenue of $24,257 by producing clinic notes that were coded at a higher level."	"The use of scribes resulted in the generation of 3,029 wRVUs"	"The level of coding varied significantly (*P*=0.001 for new patients, *P*=0.017 for follow-up patients) between physicians using scribes and those who did not. In particular, the number of new and follow-up patients coded at the highest level was higher for the physicians with scribes." "the higher level of service associated with visits using a scribe suggests that documentation may be better during those visits."

Abbreviations: wRVU=work Relative Value Unit

Appendix Table 6-3. Characteristics of Emergency Department Studies, Walker Group (Australia)

Author, year Study Design Funding Source Risk of Bias Study Period	Inclusion/Exclusion Criteria	Description of Intervention and Control	Scribe Training/Experience Scribe Duties Physician Experience	Patient Baseline Measures		Primary Objective Outcomes
				Scribe	**Non-scribe**	
Walker, 2016a[31] Prospective observational Funding: Foundation Serious ROB Study Period: July-December 2014	**Unit of analysis:** scribed versus non-scribed shifts Night shifts and shifts where scribe was shared excluded in analysis	One scribe allocated to 5 physicians and expected to attend all consultations during allocated shift. Scribed shifts for the period were compared to non-scribed shifts for same physician and non-study control physicians during the same period.	**Scribe training:** Trained by eScribe (American company) 2 years' experience in America; received Australian ED orientation and billing training **Scribe duties:** Documentation, facilitate investigations, locate consultants, book beds, request health records, write bills, deliver charts/requests to nurses) **Physician experience:** NR	**N=**921 patients **Age** (mean): 54 **Sex** (% female): 54 **% Admitted:** 50	**N=**1595 patients **Age** (mean): 53 **Sex** (% female): 53 **% Admitted:** 50	**Physician productivity** • Patients per hour per physician • Billings per patient
Walker, 2016b[32] Prospective observational Funding: Foundation Serious ROB Study Period: August 2015-February 2016	**Recruitment of scribes for training:** Sought premed students with strong academic success and interest in medical career; with qualities such as professionalism, maturity, communication skills and	Candidates attended unpaid preclinical study; successful candidates proceeded to paid clinical time with scribe trainer (emergency physician) on-site. Candidates without medical background (non-premed) were given additional unpaid vocabulary and medical training courses.	**Scribe training:** Consisted of unpaid preclinical study (e-learning and textbook course), unpaid attendance at a simulation center (including assessment and training in documentations skills), paid orientation (hospital, ED and EMR systems) and paid supervised clinical trainee shifts	**NA**	**NA**	**Cost analysis of training scribes** • Recruitment costs • Start-up costs • Training/material costs • Administration costs • Scribe salaries • Clinical trainer costs

Author, year Study Design Funding Source Risk of Bias Study Period	Inclusion/Exclusion Criteria	Description of Intervention and Control	Scribe Training/Experience Scribe Duties Physician Experience	Patient Baseline Measures		Primary Objective Outcomes
				Scribe	**Non-scribe**	
	computing/typing skills All shifts were included in calculations except night shifts		supplemented by textbook and online tutorials (unpaid). **Physician experience:** NR			
Walker, 2019[35] RCT Funding: Foundation Serious ROB Study Period: November 2015-January 2018	Permanent, salaried emergency physicians working more than one shift a week; trained scribes	Physicians worked normal shifts and were allocated a scribe for the duration of a shift. Scribed shifts vs un-scribed shifts were compared. Took place in 5 emergency departments in Victoria, Australia. Scribes rotated throughout locations.	**Scribe training:** Described in detail in Walker 2016b[32] **Scribe duties:** Documentation, arranging tests/appointments, completing EMR tasks, finding information and people, booking beds, printing discharge paperwork and clerical tasks **Physician experience:** NR	**N**=5098 **Age** (mean; 95% CI): 41.2 (40.9, 41.5) **% Male**: 52 **Admitted (%)**: 1481 (29)	**N**=23838 **Age** (mean; 95% CI): 43.1 (42.8, 43.4) **% Male**: 50 **Admitted (%)**: 7742 (32)	**Physician productivity** • Number of patients seen per physician **Patient throughput** • Door to doctor • Length of stay **Cost-benefit analysis**
Walker, 2017[33] Retrospective observational Funding: NR Moderate ROB RCT[35] data from 2016	See Walker, 2019[35]	One scribed note was randomly selected from scribed shifts and these were paired with a matched note written by the same physician without a scribe in the nearest similar shift. Notes from consultations were rated using the PDQI-9[50] tool and scores were compared	See Walker, 2019[35]	**N**=110 notes **Age** (mean; 95% CI): 58 (53, 63) **% Male**: 51 **% Admitted**: 56	**N**=110 notes **Age** (mean; 95% CI): 57 (51, 63) **% Male**: 50 **% Admitted**: 46	**Medical note quality**

Author, year Study Design Funding Source Risk of Bias Study Period	Inclusion/Exclusion Criteria	Description of Intervention and Control	Scribe Training/Experience Scribe Duties Physician Experience	Patient Baseline Measures		Primary Objective Outcomes
				Scribe	Non-scribe	
Dunlop, 2018[34] Semi-structured interviews Funding: Foundation Serious ROB Study Period: NR	**Inclusion**: Adult patients, family members of patients unable to communicate for themselves, and parents of children under 18; patients were not approached if it would delay investigations, consultations, transfers or discharges **Exclusion**: Patients whose consultation was scribed by the interviewer; patients who required isolation (infectious disease or neutropenia)	**Description of intervention:** Interview assessment on patients' satisfaction between scribed and non-scribed consultations in a not-for profit facility.	**Scribe training**: Described in detail in Walker 2016b[32] **Scribe duties**: Reported in Walker 2019[35] **Scribe experience:** 5 scribes aged 20-28 years, 60% male **Physician experience:** NR	N=95 **Age** (mean; 95% CI): 59 (54, 64) **% Male**: 50 **Admitted (%;** 95% **CI)**: 62 (52, 72)	N=118 **Age** (mean; 95% CI): 55 (49, 61) **% Male**: 49 **Admitted (%;** 95% **CI)**: 66 (57, 75)	**Patient satisfaction**

Abbreviations: ED=emergency department; EMR=electronic medical record; NR=not reported; PDQI-9= Physician Documentation Quality Instrument, Nine-item tool; RCT=randomized controlled trial; ROB=risk of bias; vs=versus
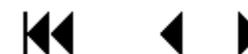
Appendix Table 6-4. Clinic Efficiency Reported Outcomes from Emergency Department Studies, Walker Group (Australia)

Author, year	Patients Seen Per Day		Door-to-Provider		Door-to-Discharge/Length of Stay	
Study design	Scribe	Non-scribe	Scribe	Non-scribe	Scribe	Non-scribe
Walker, 2016a[31] Prospective observational	**Consults/hour (95% CI)** 1.13 (1.04, 1.21) P=NR (13% physician productivity increase for primary consultations)	**Consults/hour (95% CI)** 1.02 (0.94, 1.10)	**Minutes (95% CI)** 39 (33, 44) P=NR	**Minutes (95% CI)** 42 (36, 48)	**Minutes (95% CI)** 319 (292, 347) P=NR	**Minutes (95% CI)** 317 (295, 340)
Walker, 2019[35] RCT	All shifts (n=589) **Mean (95% CI) Total PT/HR/Provider** 1.31 (1.25, 1.38) P<0.001 Senior doctor at triage (n=55) 2.80 (2.39, 3.21) Acute region (n=322) 1.12 (1.08, 1.17) Sub-acute region (n=103) 1.18 (1.02, 1.33)	All shifts (n=3296) **Mean (95% CI) Total PT/HR/Provider** 1.13 (1.11, 1.17) Senior doctor at triage (n=155) 2.27 (2.08, 2.46) Acute region (n=2172) 1.04 (1.01, 1.06) Sub-acute region (n=463) 1.23 (1.152, 1.31)	**Median Minutes (IQR)** 29 (11-22) P=.89	**Median Minutes (IQR)** 29 (11-68)	**Median Minutes (IQR)** 173 (96-208) P<.001 (19-minute absolute reduction)	**Median Minutes (IQR)** 192 (108-311)
Dunlop 2018[34] Semi-structured interview	NR	NR	**Minutes (95% CI)** 37 (29, 40) P NR	**Minutes (95% CI)** 42 (25, 60)	NR	NR

Abbreviations: CI=confidence interval; HR=hour; IQR=interquartile range; NR=not reported; PT=patient; RCT=randomized controlled trial

Appendix Table 6-5. Patient and Provider Satisfaction Reported Outcomes from Emergency Department Studies, Walker Group (Australia)

Study, year Study design	Patient Satisfaction		Provider Satisfaction
Walker, 2016a[31] Prospective observational	"No patients asked the scribe to leave or complained about the scribes presence"		"All physicians were satisfied with the initial history/physical exam capture into the chart and would like a scribe permanently." "…this scribe was good at the history capture but struggled to complete other tasks."
Dunlop 2017[34] Semi-structured interview	No difference was found between scribed and non-scribed consultations for Needs Met (P=.284), Patient Autonomy (P=.155), or Room Crowding (P=.824)		NR
	Scribes: **Net Promotor Score** 77% (95% CI 68, 85; P=.51) "You felt inhibited about disclosing your private medical history" Disagree/strongly disagree=98% P=.007 **Press Ganey Survey** "You felt comfortable giving your medical information to the doctor" Agree/strongly agree=98% P=.29 86/95 patients responded "Yes, I'm happy for my doctor to use a scribe" (remaining 9 uncertain whether scribe present or not)	**No Scribes:** **Net Promotor Score** 73% (95% CI 65, 81) "You felt inhibited about disclosing your private medical history" Disagree/strongly disagree=88% **Press Ganey Survey** "You felt comfortable giving your medical information to the doctor" Agree/strongly agree=97%	

Abbreviations: CI=confidence interval

Appendix Table 6-6. Health care and System Reported Outcomes from Emergency Department Studies, Walker Group (Australia)

Study, year Study design	Financial Productivity		Quality of Documentation	
	Scribe	**Non-scribe**	**Scribe**	**Non-scribe**
Walker, 2016a[31] Prospective observational	**Billing/consult ($; 95% CI)** 150 (87, 213) (not including cost of scribe)	**Billing/consult ($;95% CI)** 149 (77, 220) (not including cost of scribe)	NR	NR
Walker, 2019[35] RCT	Scribes earned $20.51/hr; physicians earned $165/hr. 15% gain in productivity when scribe was working generated a savings of $24.75/hr "Cost to train scribe was $5015[32] and "scribes worked 1000 once trained, generating a cost per hour worked of $5 after completion of training" "Cost saving to the hospital per scribed hour of $26.15 when hospital absorbs the cost of training"	NR	**Medical Errors:** 16 "incidents" reported where scribe was present; majority related to patient identification. "The presence of scribes at times worked as a protective factor in reducing medical error." Incident reporting rate where a scribe was present was one in every 300 encounters.	NR
Walker, 2017[33] Secondary analysis of RCT data	NR	NR	**Length of notes (words; 95% CI)** 357 (327,386) P<.0001 **PDQI-9**[50] **(mean; 95% CI)** 38.2 (37.5, 38.9) P NS **Rate of omissions** 42%(p=.90) **Sufficiency of information** 92% (p=.874)	**Length of notes (words; 95% CI)** 237 (215,259) **PDQI-9**[50] **(mean; 95% CI)** 37.8 (36.6, 38.1) **Rate of omissions** 43% **Sufficiency of information** 93%

Study, year Study design	Financial Productivity		Quality of Documentation	
	Scribe	Non-scribe	Scribe	Non-scribe
			"Omissions were numerically equivalent… but there was a qualitative difference between the omissions"	

Abbreviations: CI=confidence interval; HR=hour; NR=not reported; PDQI-9=Physician Documentation Quality Instrument, Nine-item tool; RCT=randomized controlled trial

Appendix Table 6-7. Characteristics of Emergency Department Studies, Heaton Group (United States)

Author, year Study Design Funding Source Risk of Bias Study Period	Inclusion/Exclusion Criteria	Description of Intervention and Control	Scribe Training/Experience Scribe Duties Physician Experience	Patient Baseline Measures		Primary Objective Outcomes
				Scribe	Non-scribe	
Heaton, 2016[36] Prospective Cohort Funding: NR Serious ROB Study Period: July 1, 2015 to September 30, 2015	**Inclusion:** Patients roomed between July 1, 2015 to September 30, 2015 **Exclusion:** Behavioral health patients, resuscitation patients, patients who left without being seen, and nurse-only visits	Scribes were assigned to a single provider or team for the duration of the provider's shift and were expected to enter the documentation into the electronic medical record for the provider. Each scribe provided 1-to-1 provider support. Providers served patients with Emergency Severity Index of 1-5. **Description of control:** Non-scribed encounters functioned as usual with providers constructing their own documentation in medical record through transcription, voice recognition software, or self-entry.	**Scribe training:** Recruited and trained through in-house training program with a defined curriculum developed by a physician with prior experience implementing scribe programs. May 2015 marked the completion of scribe training. **Scribe experience:** Undergraduate and recent college graduates. Scribes were largely pre-health students. **Physician experience:** NR	N=2091 **Age** (median): 58 **% Male**: 47 **% Admitted**: 44	N=5924 **Age** (median): 59 **% Male:** 49 **Admitted**: 45	**Patient specific throughput**

Author, year Study Design Funding Source Risk of Bias Study Period	Inclusion/Exclusion Criteria	Description of Intervention and Control	Scribe Training/Experience Scribe Duties Physician Experience	Patient Baseline Measures		Primary Objective Outcomes
				Scribe	**Non-scribe**	
		Providers included: Attendings, senior resident physicians, nurse practitioners, and physician assistants				
Heaton, 2017a[37] Prospective Cohort Funding: NR Serious ROB Study Period**:** February 1, 2016 to April 30, 2016	**Inclusion**: Patients roomed between February 1, 2016 and April 30, 2016 **Exclusion**: Behavioral health patients, patients who left without being seen, and nurse-only visits.	**Description of intervention:** Scribes were assigned to a single provider or team for the duration of the provider's shift and were expected to enter the documentation into the electronic medical record for the provider. Each scribe provided 1-to-1 provider support. Providers served patients with Emergency Severity Index of 1-5. **Description of control:** Non-scribed encounters functioned as usual with providers using either their own documentation in the medical record through transcription, voice recognition software, or self-entry in the electronic medical record. **Providers included**: Attending physicians,	**Scribe training**: Recruited and trained through in-house training program with a defined curriculum developed by a physician with prior experience implementing scribe programs. Training began in February 2015 (one year before the study period). **Physician experience:** NR	N=3049 **Age** (median): 54 **% Male**: 48 **% Admitted**: 37 **Scribe experience:** Undergraduate and recent college graduates. The scribes were largely pre-health students.	N=3070 **Age** (median): 54 **% Male**: 49 **% Admitted**: 36	**Throughput one year after implementation**

Author, year Study Design Funding Source Risk of Bias Study Period	Inclusion/Exclusion Criteria	Description of Intervention and Control	Scribe Training/Experience Scribe Duties Physician Experience	Patient Baseline Measures		Primary Objective Outcomes
				Scribe	**Non-scribe**	
		residents, senior resident physicians, nurse practitioners, and physician assistants				
Heaton, 2017b[38] Prospective Cohort Funding: NR Moderate ROB Study Period: February 1, 2015 to September 30, 2015	**Inclusion**: All patients seen between February 1, 2015 and September 30, 2015 **Exclusion**: None	**Description of intervention:** Scribes were assigned to a single provider for the duration of the provider's shift and were expected to enter the documentation into the electronic medical record for the provider. Each scribe provided 1-to-1 provider support. Providers served patients with Emergency Severity Index of 1-5. **Description of control:** Non-scribed encounters functioned as usual with providers constructing their own documentation in medical record via transcription, voice recognition software, or self-entry. **Providers included**: Attending physician, senior resident physicians, nurse practitioners, and physician assistants	**Scribe training**: Recruited and trained through in-house training program developed by a physician with experience in scribe program implementation. Training included basic medical terminology and components of the medical chart, including HPI, ROS, PE, and MDM. Scribes had "on the job" training with selected physician trainer for 8-10 9-hour clinical shifts during the onboarding process, and their progress was evaluated through quizzes. **Scribe experience:** Undergraduate and recent college graduates **Physician experience:** NR	**N**=5853 visits **Age** (mean, SD): 54.3 (20.9) **% Male**: 49 **% Admitted**: NR	**N**=34073 visits **Age** (mean, SD): 53.4 (20.9) **% Male**: 49 **% Admitted**: NR	**RVUs per patient**

Author, year Study Design Funding Source Risk of Bias Study Period	Inclusion/Exclusion Criteria	Description of Intervention and Control	Scribe Training/Experience Scribe Duties Physician Experience	Patient Baseline Measures		Primary Objective Outcomes
				Scribe	**Non-scribe**	
Heaton, 2018[39] Prospective Cohort Funding: Grant funded Serious ROB Study Period: January 31, 2017 to April 21, 2017	**Inclusion**: Attending physicians and scribes were observed between January 31, 2017 and April 21, 2017. The included shifts were limited to Tuesday-Friday in one area of the emergency department that manages adult patients with Emergency Severity Index levels of 2-5. **Exclusion**: Shifts on Saturday-Monday.	**Description of intervention:** Scribes were assigned to a single provider or team for the duration of the provider's shift and were expected to enter the documentation into the electronic medical record for the provider. Each scribe provided 1-to-1 provider support. Providers served patients with Emergency Severity Index of 2-5. **Description of Control**: Non-scribed encounters functioned as usual. **Providers included**: Attending physicians	**Scribe training**: Recruited and trained through in-house training program with a defined curriculum developed by a physician with prior experience implementing scribe programs. **Scribe experience:** Undergraduate and recent college graduates. The scribes were largely pre-health students. Experience ranged from 6 months to 2 years. **Physician experience:** NR	**N**=24 shifts observed **Age**: NR **% Male**: NR **% Admitted**: NR	**N**=24 shifts observed **Age**: NR **% Male**: NR **% Admitted**: NR	**ED physician time management on shift**
Heaton, 2019a[40] Prospective Cohort Funding: NR Study Period: May 5, 2018 to July 31, 2018	**Inclusion**: Patients registered between May 5, 2018 and July 31, 2018. All adults roomed in a high acuity area of the adult emergency department open 24 hours a day staffed with a board-certified Emergency Medicine attending physician, senior resident, and	**Description of intervention:** Scribes were assigned to a single provider or team for the duration of the provider's shift and were expected to enter the documentation into the electronic medical record for the provider. Each scribe provided 1-to-1 provider support. Providers served patients with Emergency Severity Index of 1-5.	**Scribe training**: Recruited and trained through in-house training program. **Scribe experience:** NR **Physician experience:** NR	**N**=2317 patients **Age**: NR **% Male**: 50 **% Admitted**: 39	**N**=2312 patients **Age**: NR **% Male**: 50 **% Admitted**: 40	**Throughput and revenue capture during a transition between 2 electronic medical record systems**

Author, year Study Design Funding Source Risk of Bias Study Period	Inclusion/Exclusion Criteria	Description of Intervention and Control	Scribe Training/Experience Scribe Duties Physician Experience	Patient Baseline Measures		Primary Objective Outcomes
				Scribe	**Non-scribe**	
	an intern were included. All pediatric patients roomed in Treatment Area B were also included (not relevant for this review). **Exclusion**: None	Non-scribed encounters functioned as usual with providers using their preferred method to construct their own document in the medical record. The study occurred during the transition between 2 electronic medical record systems **Providers included**: Attending physician, a senior resident, and an intern				
Heaton, 2019b[40] Prospective Cohort Serious ROB Funding: In part by Mayo Clinic Department of Emergency Medicine Study Period: April 2016 to May 2016	**Inclusion**: Select shifts from 3:00 pm to 11:00 pm between April 2016 and May 2016 **Exclusion**: None	**Description of intervention:** Research assistants observed attending physicians with and without scribes for a total of 64 hours. On scribe shifts, a medical scribe entered data into the electronic medical record No physician was shadowed twice. Providers served patients with Emergency Severity Index of 1-5. **Description of Control:**	**Scribe training**: NR **Physician experience:** NR	**N**=4 shifts observed for a total of 32 hours **Age**: NR **% Male**: NR **% Admitted**: NR	**N**=4 shifts observed for a total of 32 hours **Age**: NR **% Male**: NR **% Admitted**: NR	**Physician documentation time and documentation costs**

Author, year Study Design Funding Source Risk of Bias Study Period	Inclusion/Exclusion Criteria	Description of Intervention and Control	Scribe Training/Experience Scribe Duties Physician Experience	Patient Baseline Measures		Primary Objective Outcomes
				Scribe	**Non-scribe**	
		Non-scribed shifts functioned as usual with providers using their preferred method to construct documentation in the electronic health record through transcription, voice recognition software, or self-entry. **Providers included**: Attending physicians				

Abbreviations: ED=emergency department; HPI=history of present illness; MDM=medical decision making; NR=not reported; PE=physical examination; ROS=review of systems; ROB=risk of bias; RVU=relative value unit; SD=standard deviation

Appendix Table 6-8. Clinic Efficiency Reported Outcomes from Emergency Department Studies, Heaton Group (United States)

Author, year Study design	Patients Seen Per Day		Door-to-Provider		Door-to-Discharge/Length of Stay		Appointment Length		Time-to-Disposition	
	Scribe	Non-scribe	Scribe	Non-scribe	Scribe	Non-scribe	Scribe	Non-scribe	Scribe	Non-scribe
Heaton, 2016[36] Prospective cohort	*"For attending physicians, no benefit in patients per hour was demonstrated"* (data NR)		*All providers N=2091* **Median Minutes: 23** P=.29 *Attendings N=314* **Median Minutes: 117** P=.051 *PGY-2 residents N=612* **Median Minutes: 17** P=.15 *PGY-3 residents N=860* **Median Minutes: 16** P=.17 *NP/PA N=183* **Median Minutes: 90** P=.68	*All providers N=5924* **Median Minutes: 21** *Attendings N=599* **Median Minutes: 92** *PGY-2 residents N=771* **Median Minutes: 16** *PGY-3 residents N=1062* **Median Minutes: 16** *NP/PA N=215* **Median Minutes: 89**	*All providers N=2091* **Median Minutes: 265** P=.028 *Attendings N=314* **Median Minutes: 322** P=.057 *PGY-2 residents N=612* **Median Minutes: 263** P=.55 *PGY-3 residents N=860* **Median Minutes: 244** P=.021 *NP/PA N=183* **Median Minutes: 282** P=.39	*All providers N=5924* **Median Minutes: 255** *Attendings N=599* **Median Minutes: 297** *PGY-2 residents N=771* **Median Minutes: 249** *PGY-3 residents N=1062* **Median Minutes: 262** *NP/PA N=215* **Median Minutes: 288**	***In treatment room*** *All providers N=2091* **Median Minutes: 208** P=.14 *Attendings N=314* **Median Minutes: 204** P=.17 *PGY-2 residents N=612* **Median Minutes: 215** P=.56 *PGY-3 residents N=860* **Median Minutes: 208** P=.44 *NP/PA N=183* **Median Minutes: 171** P=.31	***In treatment room*** *All providers N=5924* **Median Minutes: 210** *Attendings N=599* **Median Minutes: 199** *PGY-2 residents N=771* **Median Minutes: 220** *PGY-3 residents N=1062* **Median Minutes: 223** *NP/PA N=215* **Median Minutes: 173**	*All providers N=2091* **Median Minutes: 153** P=.15 *Attendings N=314* **Median Minutes: 149** P=.67 *PGY-2 residents N=612* **Median Minutes: 153** P=.77 *PGY-3 residents N=860* **Median Minutes: 155** P=.92 *NP/PA N=183* **Median Minutes: 129** P=.93	*All providers N=5924*[36] **Median Minutes: 149** *Attendings N=599* **Median Minutes: 151** *PGY-2 residents N=771* **Median Minutes: 156** *PGY-3 residents N=1062* **Median Minutes: 152** *NP/PA N=215* **Median Minutes: 125**

Author, year Study design	Patients Seen Per Day		Door-to-Provider		Door-to-Discharge/Length of Stay		Appointment Length		Time-to-Disposition	
	Scribe	Non-scribe	Scribe	Non-scribe	Scribe	Non-scribe	Scribe	Non-scribe	Scribe	Non-scribe
Heaton 2017a[37] Prospective cohort	NR	NR	All patients N=3049 **Median Minutes:** 20 P=.84 Area A (attending with residents) N=2178 **Median Minutes:** 14 P=.25 Area B (attending with NP/PA) N=871 **Median Minutes:** 43 P=.70	All patients N=3070 **Median Minutes:** 19 Area A (attending with residents) N=2235 **Median Minutes:** 15 Area B (attending with NP/PA) N=835 **Median Minutes:** 45	*All patients N=3049* **Median Minutes:** 215 P=.34 *Area A (attending with residents) N=2178* **Median Minutes:** 212 P=.18 *Area B (attending with NP/PA) N=871* **Median Minutes:** 221 P=.80	*All patients N=3070* **Median Minutes:** 214 *Area A (attending with residents) N=2235* **Median Minutes:** 211 *Area B (attending with NP/PA) N=835* **Median Minutes:** 222	***In treatment room*** *All patients N=3049* **Median Minutes**: 176 P=.28 *Area A (attending with residents) N=2178* **Median Minutes**: 179 P=.081 *Area B (attending with NP/PA) N=871* **Median Minutes**: 172 P=.40	***In treatment room*** *All patients N=3070* **Median Minutes**: 181 *Area A (attending with residents) N=2235* **Median Minutes**: 185 *Area B (attending with NP/PA) N=835* **Median Minutes**: 168	*All patients N=3049* **Median Minutes**:128 P=.51 *Area A (attending with residents) N=2178* **Median Minutes**: 129 P=.21 *Area B (attending with NP/PA) N=871* **Median Minutes**: 124 P=.42	*All patients N=3070* **Median Minutes**: 128 *Area A (attending with residents) N=2235* **Median Minutes**: 130 *Area B (attending with NP/PA) N=835* **Median Minutes**: 119
Heaton, 2018[39] Prospective cohort	NR	NR	NR	NR	NR	NR	*Time at patient bedside N=24 shifts* **Median Minutes:** 135 **Mean Minutes**	*Time at patient bedside N=24 shifts* **Median Minutes:** 132 **Mean Minutes**	NR	NR

Author, year Study design	Patients Seen Per Day		Door-to-Provider		Door-to-Discharge/Length of Stay		Appointment Length		Time-to-Disposition	
	Scribe	Non-scribe	Scribe	Non-scribe	Scribe	Non-scribe	Scribe	Non-scribe	Scribe	Non-scribe
							(SD): 138 (49) P=.88	(SD): 140 (49)		
Heaton, 2019a[41] Prospective cohort	NR	NR	*All patients N=2317* **Median Minutes: 25** P=.064 *All patients – morning shift N=772* **Median Minutes: 19** P=.64 *All patients – afternoon shift N=788* **Median Minutes: 33** P=.42 *All patients – overnight shift N=757* **Median Minutes: 21** P=.01	*All patients N=2312* **Median Minutes: 27** *All patients – morning shift N=736* **Median Minutes: 20** *All patients – afternoon shift N=748* **Median Minutes: 42** *All patients – overnight shift N=828* **Median Minutes: 28**	*All patients N=2317* **Median Minutes: 267** P=.34 *All patients – morning shift N=772* **Median Minutes: 257** P=.13 *All patients – afternoon shift N=788* **Median Minutes: 291** P=.86 *All patients – overnight shift N=757* **Median Minutes: 265** P=.86	*All patients N=2312* **Median Minutes: 272** *All patients – morning shift N=736* **Median Minutes: 267** *All patients – afternoon shift N=748* **Median Minutes: 294** *All patients – overnight shift N=828* **Median Minutes: 264**	***In treatment room*** *All patients N=2317* **Median Minutes: 222** P=.67 *All patients – morning shift N=772* **Median Minutes: 233** P=.11 *All patients – afternoon shift N=788* **Median Minutes: 224** P=.91 *All patients – overnight shift N=757* **Median Minutes: 210** P=.092	***In treatment room*** *All patients N=2312* **Median Minutes: 221** *All patients – morning shift N=736* **Median Minutes: 245** *All patients – afternoon shift N=748* **Median Minutes: 223** *All patients – overnight shift N=828* **Median Minutes: 198**	*All patients N=2317* **Median Minutes: 166** P=.32 *All patients – morning shift N=772* **Median Minutes: 179** P=.18 *All patients – afternoon shift N=788* **Median Minutes: 169** P=.94 *All patients – overnight shift N=757* **Median Minutes: 156** P=.011	*All patients N=2312* **Median Minutes: 163** *All patients – morning shift N=736* **Median Minutes: 189** *All patients – afternoon shift N=748* **Median Minutes: 168** *All patients – overnight shift N=828* **Median Minutes: 146**

Abbreviations: NR=not reported; NP=nurse practitioner; PA=physician assistant; PGY=postgraduate year; SD=standard deviation

Appendix Table 6-9. Health care and System Reported Outcomes from Emergency Department Studies, Heaton Group (United States)

Study, year Study design	Financial Productivity		Relative Value Units	
	Scribe	Non-scribe	Scribe	Non-scribe
Heaton, 2017b[38] Prospective cohort	NR	NR	**Mean RVUs per patient:** 4.04 P<.001 Patients with emergency severity levels of 2 and 3 had higher RVUs with scribes (P<.001). Not significantly different in emergency severity levels 1, 4, and 5 (p between 0.10 and 0.63) Scribes had higher RVUs in chest pain, heart, and respiratory emergencies (P<.001); ear throat, and nose emergencies (P<.04); leg fractures (p=.027); and psychiatric emergencies (P=.002) Scribes had lower RVUs in vision emergencies (P=.027) All other diagnostic categories were not significant	**Mean RVUs per patient:** 3.84
Heaton, 2019a[41] Prospective cohort	NR	NR	**Total Mean RVUs:** 4.79 P=.76	**Total Mean RVUs:** 4.72
Heaton, 2019b[40] Prospective cohort	**Costs of charting per shift** (reported estimates based on national hourly rates): $488 ($200 per clinical hour x 2 hours + $11 per scribe hour x 8 hours)	**Costs of charting per shift** $600 ($200 per clinical hour x 3 hours)	NR	NR

Abbreviations: RVU=relative value units

Appendix Table 6-10. Characteristics of Emergency Department Studies

Author, year Study Design Funding Source Risk of Bias Study Period	Inclusion/ Exclusion Criteria	Description of Intervention and Control	Scribe Training/Experience Scribe Duties Physician Experience	Patient Baseline Measures		Primary Objective Outcomes
				Scribe	Non-scribe	
Allen, 2014[42] US Retrospective Cohort (pre-post) and Electronic Survey Serious ROB **Funding**: NR **Study Period**: June 1, 2012 to April 30, 2014	**Inclusion**: All patients seen during study period **Exclusion**: Patients seen during May 2013 due to "crossover and inconsistency"	**Description of intervention**: Pre-post assessment of scribes in an adult emergency department. Prescribe time frame: June 1, 2012 to April 30, 2013; Post scribe time frame: June 1, 2013 to April 30, 2014. **Providers included**: All providers except first year residents. Providers were emailed electronic survey to assess satisfaction	**Scribe training**: NR **Scribe duties**: Medical documentation services excluding first year residents; scribes do not complete order entries **Scribe experience**: NR **Providers experience**: NR	**N**=NR **Age**: NR **% Male**: NR **% admitted**: NR	**N**=NR **Age**: NR **% Male**: NR **% admitted**: NR	**ED throughput** • Door-to-provider • Time-to-disposition • Left without being seen **Provider satisfaction**
Arya, 2010[43] US Retrospective Cohort (pre-post) Moderate ROB **Funding**: NR **Study Period**: July 2006 to December 2007	**Inclusion**: Patients seen by between July 2006 to December 2007; during shifts fully or partially covered by a scribe. **Exclusion**: None	**Description of intervention**: Pre-post assessment of scribes at an academic urban level 1 trauma center. Physician shifts with full scribe coverage were matched to shifts from same provider during same shift time period without full scribe coverage (<4 hours) **Providers included**: Emergency medicine	**Scribe training**: 60-hour program, 2 years of clerical experience required, including familiarity with common software packages required. Knowledge of medical terminology and coding is preferred. **Scribe duties**: Scribes provided medical documentation services and communicated laboratory and x-ray results **Scribe experience**: NR **Providers experience**: NR	**N**=13 providers, 243 shifts **Age**: NR **% Male**: NR **% Admitted**: NR	**N**=13 providers, 243 shifts **Age**: NR **% Male**: NR **% Admitted**: NR	**Patients per hour Turn-around time RVUs**

		physicians and physicians' assistants				
Bastani, 2013[44] US Prospective Cohort (pre-post) Serious ROB **Funding**: NR **Study Period**: Pre-scribe baseline: Dec 2009-Jan 2010 Post-scribe**:** May-July 2010	**Inclusion**: Patients seen during study period **Exclusion**: Cases staffed with physician assistants, residents, or pediatric nurse practitioners	**Description of intervention:** Pre-post assessment of scribes at a suburban community hospital. Scribe and computerized physician order entry interventions implemented at same time. **Providers included**: Emergency medicine physicians	**Scribe training**: Program instituted by PhysAssist which provided turn-key operation for ED employing, training, managing, and scheduling the scribes. Scribes were pre-med/pre-nursing/pre-PA students. **Scribe duties**: Scribes provided medical documentation services **Scribe experience**: NR **Provider experience**: NR	**N**=12609 patients **Age**: NR **% Male**: NR **% Admitted**: NR	**N**=11729 patients **Age**: NR **% Male**: NR **% Admitted**: NR	**ED throughput** • Door-to-room • Door-to-provider • Time-to-disposition • Length of stay **Patient Satisfaction**
Friedson, 2018[45] US RCT Moderate ROB **Funding**: Foundation, industry **Study Period**: March 2015 to November 2015	**Inclusion**: Physicians volunteered for experiment **Exclusion**: Emergency rooms and overnight shifts with small patient loads	**Description of intervention:** RCT assessment of scribes in multiple suburban hospitals. Assigned to work 1 to 1 with providers. Scribes randomly assigned to providers normally scheduled shifts. Scribed shifts were compared to non-scribed shifts. Total RVUs were compared as well as "trimmed RVUs", which removed the lowest and highest 10%. **Providers included**: Emergency medicine physicians	**Scribe training**: Employed by Essia Health **Scribe duties**: Medical documentation services. **Scribe experience**: NR **Providers experience**: NR	**N**=472 shifts (16 providers) **Age**: NR **% Male**: NR **% Admitted**: NR	**N**=433 shifts (16 providers) **Age**: NR **% Male**: NR **% Admitted**: NR	**Clinic efficiency** • Patients per shift • Time-to-disposition **Billed RVUs**

Graves, 2018[46] Canada Prospective Cohort (pre-post) Serious ROB **Funding**: Foundation, hospital **Study Period**: January 2015 to April 2015	**Inclusion**: All shifts during study period **Exclusion**: NR	**Description of intervention:** Pre-post assessment of scribes in a non-academic community hospital. Assigned to work 1 to 1 with providers. Scribes were only allocated to evening shifts. **Providers included**: Emergency medicine physicians	**Scribe training**: Employed by Medical Scribes of Canada. Scribes trained in medical terminology, disease presentations, and confidentiality. **Scribe duties**: Medical documentation of patient encounters, flow management, and clerical support. **Scribe experience:** College students enrolled in pre-health degree, aged 18-23 years **Providers experience**: 11 years (SD 10.1)	**N**=97shifts (22 providers) **Age**: NR **% Male**: NR **% Admitted**: NR	**N**=61 shifts (22 providers) **Age**: NR **% Male**: NR **% Admitted**: NR	**Clinic Efficiency** • Patients per hour
Hess, 2015[47] US Prospective Cohort (pre-post) Serious ROB **Funding**: NR **Study Period**: 2011-2012	**Inclusion**: Physicians with at least half of clinical time spent at one of the 2 scribe sites **Exclusion**: NR	**Description of intervention:** Pre-post assessment of scribes in 2 academic medical centers. Assigned to work 1 to 1 with providers. Surveys administered to capture provider satisfaction. **Providers included**: Emergency medicine physicians with clinical and teaching responsibilities	**Scribe training**: Program instituted and managed by Emergency Medical Scribe Systems. Scribes received on the job training and are considered proficient after 15 shifts and skilled after 45 shifts. **Scribe duties**: Transcribes illness history, exam findings, differential diagnosis, and decision making; documents orders, procedures, results, consultant input, and final dispositions **Scribe experience:** College students or recent graduated interested in health science careers **Providers experience**: NR	**N**=49 providers **Age**: NR **% Male**: NR **% Admitted**: NR	**N**=54 providers **Age**: NR **% Male**: NR **% Admitted**: NR	**Clinic Efficiency** • Length of stay • Left without being seen • Patients per month **Provider satisfaction** **RVUs per hour**
Ou, 2017[48] US	**Inclusion**: NR **Exclusion**: NR	**Description of intervention:** Pre-post assessment of resident perspectives before	**Scribe training**: Employed by an outside vendor. Scribes undergo 6-8 weeks of training in medical	**Post-scribe:** **N**=47 residents **Age**: NR	**Pre-scribe:** Same 47 residents	**Provider satisfaction**

Prospective Cohort (pre-post surveys) **Funding**: NR **Study Period**: September 2015 to April 2016		and after implementation of a scribe program in a large, urban academic medical center. Assigned to work 1 to 1 with providers. **Providers included**: Emergency medicine residents	terminology, chart documentation, billing, and risk management and 50 hours of floor-training under senior scribe who provides real-time feedback. **Scribe duties**: Medical documentation services following patient encounters. Scribes do not have direct patient contact. **Scribe experience**: College students or recent graduated interested in health science careers **Providers experience**: NR	**% Male**: NR **% Admitted**: NR		
Shuaib, 2017[49] US Prospective Cohort (pre-post) **Funding**: None **Study Period**: July 2015 to February 2016	**Inclusion**: All patients seen by a physician during the study period **Exclusion**: patients seen by nurse practitioner or physician assistant were excluded	**Description of intervention**: Pre-post assessment of scribes in a suburban non-academic level 2 community trauma center. Assigned to work 1 to 1 with providers. **Providers included**: Emergency medicine physicians	**Scribe training**: Program instituted by a scribe system operating company. Scribes received on the job training and are considered proficient after 20 shifts and skilled after 40 shifts. **Scribe duties**: Medical documentation services. **Scribe experience**: College students or recent graduated interested in health science careers **Providers experience**: NR	**N**=13,598 patient encounters **Age**: NR **% Male**: NR **% Admitted**: NR	**N**=12,721 patient encounters **Age**: NR **% Male**: NR **% Admitted**: NR	**Clinic Efficiency** • Waiting time • Time-to-disposition • Length of stay • Patients per hour **RVUs per hour** **Patient Satisfaction**

Abbreviations: NR=not reported; ROB=risk of bias; RVU=relative value units; SD=standard deviation; YR=years; US=United States of America

Appendix Table 6-11. Clinic Efficiency Reported Outcomes from Emergency Department Studies

Author, year Study design	Patients Seen Per Day/Hour/Shift		Door-to-Room Waiting Time		Door-to-Provider		Time-to-Disposition Appointment Length		Door-to-Discharge/Length of Stay		Left Without Being Seen	
	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe
Allen, 2014[42] Pre-post	*All patients registered visits* **Mean hours:** 181.7	*All patients registered visits* **Mean hours:** 180.7 P=.47	*All patients Door-to-room* **Mean hours:** 0.55	*All patients Door-to-room* **Mean hours:** 0.54 P=.65	*All patients* **Mean hours:** 1.28	*All patients* **Mean hours:** 1.34 P=.07	*All patients Provider - to-disposition* **Mean hours:** 2.82	*All patients Provider - to-disposition* **Mean hours:** 2.61 P=.<.0001	*All patients Door-to-exit* **Mean hours:** 5.76 *Admitted patients Door-to-exit* **Mean hours:** 7.61 *Discharged patients Door-to-exit* **Mean hours:** 5.07 *All patients Door-to-disposition* **Mean hours:** 4.16 *Admitted patients*	*All patients Door-to-exit* **Mean hours:** 5.62 *Admitted patients Door-to-exit* **Mean hours:** 8.27 P<.0001 *Discharged patients Door-to-exit* **Mean hours:** 4.89 P<.012 *All patients Door-to-disposition* **Mean hours:** 3.89 P<.0001 *Admitted patients*	*All patients % LWBS* 5	*All patients % LWBS* 5 P=.38

Author, year Study design	Patients Seen Per Day/Hour/Shift		Door-to-Room Waiting Time		Door-to-Provider		Time-to-Disposition Appointment Length		Door-to-Discharge/Length of Stay		Left Without Being Seen	
	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe
									Door-to-disposition **Mean hours:** 3.63 *Discharged patients* *Door-to-disposition* **Mean hours:** 4.57	*Door-to-disposition* **Mean hours:** 3.25 P<.0001 *Discharged patients* *Door-to-disposition* **Mean hours:** 4.41 P=.03		
Arya, 2010[43] Pre-post	NR	**Additional patients per 10-hour shift: 8.0** 0.08 (95% CI 0.04, 0.12) P=.002	NR	NR	NR	NR	NR	NR	NR	**Turn-around time (min) for every 10% increment in scribe usage during a shift:** 0.4 (95% CI -5.3, 6.1) P=0.88	NR	NR
Bastani, 2013[44] Pre-post	NR	NR	*All patients* *Door-to-room* **Mean min:** 35	*All patients* *Door-to-room* **Mean min:** 34	*All patients* **Mean min:** 74	*All patients* **Mean min:** 61 P<.0001	*All patients* *Provider-to-disposition* **Mean min:** 237	*All patients* *Provider-to-disposition* **Mean min:** 185	*Admitted patients* *LOS* **Mean min:** 448	*Admitted patients* *LOS* **Mean min:** 442	NR	NR

Author, year Study design	Patients Seen Per Day/Hour/Shift		Door-to-Room Waiting Time		Door-to-Provider		Time-to-Disposition Appointment Length		Door-to-Discharge/Length of Stay		Left Without Being Seen	
	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe
				P<.0001				P<.0001	*Discharged patients LOS* **Mean min:** 289	P<.0001 *Discharged patients LOS* **Mean min:** 269 P<.0001		
Friedson, 2018[45] RCT	*Patients per shift* 17.8	*Patients per shift* 18.6 Mean difference 0.80 (SD 0.40) P<.05	NR	NR	NR	NR	*Door to decision* **Mean hours (SD):** 4.3 (2.7)	*Door to decision* **Mean hours (SD):** 3.8 (1.7) P<.01	NR	NR	NR	NR
Graves, 2018[46] Pre-post	*Patients per hour per physician (in 8-hour shift)* **Mean**(SD): 2.49 (0.60)	*Patients per hour per physician (in 8-hour shift)* **Mean**(SD): 2.81 (0.78) P=.006	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Hess, 2015[47] Pre-post	*Patients per month* **Mean:** 1798	*Patients per month* **Mean:** 1887 (95% CI 31.8, 145.9) P=.04	NR	NR	NR	NR	NR	NR	*LOS (hours)* **Monthly Mean:** 5.4	*LOS (hours)* **Monthly Mean:** 5.6 (95CI -0.05, 0.33) P=0.15	*Patients LWBS* **Monthly Mean:** 2.9	*Patients LWBS* **Monthly Mean:** 4.4 (95% CI 0.83, 2.11) P=<.01

Author, year Study design	Patients Seen Per Day/Hour/Shift		Door-to-Room Waiting Time		Door-to-Provider		Time-to-Disposition Appointment Length		Door-to-Discharge/Length of Stay		Left Without Being Seen	
	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe
	Patients per hour *Sept 2011* Mean: 2.05 ***Patients per hour*** *Oct 2011* Mean: 1.92 ***Patients per hour*** *Nov 2011* Mean: 1.92 ***Patients per hour*** *Dec 2011* Mean: 1.89	***Patients per hour*** *Sept 2012* Mean: 2.13 P=.21 ***Patients per hour*** *Oct 2012* Mean: 1.99 P=.36 ***Patients per hour*** *Nov 2012* Mean: 2.04 P=.23 ***Patients per hour*** *Dec 2012* Mean: 2.01 P=.37										
Ou, 2017[48] Pre-post	NR	"Scribes have allowed me to see more patients than I would NR without them" Yes=77% (36/47) No=9% (4/47)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Author, year Study design	Patients Seen Per Day/Hour/Shift		Door-to-Room Waiting Time		Door-to-Provider		Time-to-Disposition Appointment Length		Door-to-Discharge/Length of Stay		Left Without Being Seen	
	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe
Shuaib, 2017[49] Pre-post	*Patients per hour Mean (SD)* 2.3 (0.3)	*Patients per hour Mean (SD)* 3.2 (0.6) P<.0001	*Door to room* Mean min: 41	*Door to room* Mean min: 37 P<.0001	*Door-to-provider* Mean min: 61	*Door-to-provider* Mean min: 56 P<.0001	*Provider to disposition* Mean min: 237 **Time-motion analysis Mean min (SD)** Total visit: 25.9 Patient-doctor interaction: 4 (0.57)	*Provider to disposition* Mean min: 228 P<.0001 **Time-motion analysis Mean min (SD)** Total visit: 23.2 p=NR Patient-doctor interaction: 7.8 (1.2) p<.01	*Admitted patients LOS* Mean min: 507 *Discharged patients LOS* Mean min: 303	*Admitted patients LOS* Mean min: 473 P<.0001 *Discharged patients LOS* Mean min: 287 P<.0001	NR	NR

Abbreviations: CI=confidence interval; LOS=length of stay; LWBS=left without being seen; min=minutes; NR=not reported; RCT=randomized controlled trial; SD=standard deviation

Appendix Table 6-12. Patient and Provider Satisfaction Reported Outcomes from Emergency Department Studies

Study, year Study design	Patient Satisfaction		Provider Satisfaction	
	Pre-scribe	**Post-scribe**	**Pre-scribe**	**Post-scribe**
Allen, 2014[42] Post only survey	NR	NR	NR	N=30 providers "Scribes are a valuable addition" =100% yes "Scribes increase workplace satisfaction" =77% yes "Scribes increase quality of life" =90% yes
Bastani, 2013[44] Pre-post	**Press Ganey Survey** Overall patient satisfaction 58th percentile	**Press Ganey Survey** Overall patient satisfaction 75th percentile	**Press Ganey Survey** Overall physician satisfaction 62nd percentile	**Press Ganey Survey** Overall physician satisfaction 92nd percentile
Hess, 2015[47] Post only survey	NR	NR	NR	N=71 providers "Liked or loved working with scribes" =62% yes "Overall positive or very positive attitude toward scribes" =74% yes "Positive or very positive changes in efficiency" =82% yes
Ou, 2017[48] Pre-post survey	NR	NR	"I have enough face-to-face teaching with the attendings during my shift" Disagree=55% (26/47) Agree=17% (8/47)	"I have enough face-to-face teaching with the attendings during my shift" Disagree=13% (6/47) Agree=55% (26/47) P<.001 "My interactions with attending have improved with implementation scribes" Yes=85% (40/47)

Study, year	Patient Satisfaction		Provider Satisfaction	
Study design	Pre-scribe	Post-scribe	Pre-scribe	Post-scribe
				No=4% (2/47) "Scribes have improved my overall education as a resident in the emergency department" Yes=79% (37/47) No=2% (1/47)
Shuaib, 2017[49] Pre-post survey	Likert scale (1=poor, 5=excellent) Doctor carefully listened to concerns; Doctor explained things in a way you can understand; Meticulousness of examination; Doctors instructions concerning follow-up care; Doctor was courteous P=NS Doctor provided satisfactory feedback to questions=3.9 (+/-0.3)	"Pre-scribe patient satisfaction was high and remained high in post-scribe cohort" Doctor provided satisfactory feedback to questions=4.7 (+/-0.1) P<.01	Physician satisfaction=66%	Physician satisfaction=81%

Abbreviations: NR=not reported; NS=non-significant

Appendix Table 6-13. Health care and System Reported Outcomes from Emergency Department Studies

Study, year Study design	Financial Productivity		Relative Value Units	
	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe
Arya, 2010[43] Pre-post	NR	NR		***Additional RVUs per 10-hour shift***: 0.24 (95% CI 0.10, 0.38) P=.0011
Friedson, 2018[45] RCT	NR	NR	***Total RVUs*** 74.34 (SD 25.64) ***Total RVUs (trimmed)*** 72.01 (SD 20.78)	***Total RVUs***: 76.49 (SD 26.43) Mean difference 2.14 (SD 1.75) P NS ***Total RVUs (trimmed)***: 76.88 (SD 20.12) Mean difference 4.87 (SD 1.45) P<.01
Graves, 2018[46] Pre-post	Physician $1200/shift ($150 per hour)* *Costs estimated depending on region, clinical load, practice models and physician pace	Scribe costs $216/shift ($27 per hour)* "Given that a scribe may be associated with a mean increase of 13% in productivity "costs" to a physician using a scribe would be about $60 relative to what their earning without a scribe would be"	NR	NR
Hess, 2015[47] Pre-post	NR	***NR***	***RVUs per hour*** *September 2011:* 0.0014 % change=8.06 Mean difference=0.0008 95% CI [-0.00001, - 0.00014; P=.03] *October 2011:* 0.0017 % change=13.6% Mean difference=0.00016 95% CI [-0.00007, - 0.00025; P<.01] *November 2011:* 0.0014 % change=10.2% Mean difference=0.0001	***RVUs per hour*** *September 2012:* 0.0013 *October 2012:* 0.0015 *November 2012:* 0.0013

Study, year Study design	Financial Productivity		Relative Value Units	
	Pre-scribe/ No scribe	Post-scribe/ Scribe	Pre-scribe/ No scribe	Post-scribe/ Scribe
			95% CI [-0.00001, - 0.00018; P=.03]	
			December 2011: 0.0017 % change=2.64% Mean difference=0.00003 95% CI [-0.00006, - 0.00011; P=.57]	*December 2012:* 0.0017
			RVUs per patient *September 2011:* 0.0007 % change=1.84 Mean difference=0.00001 95% CI [-0.00001, - 0.00003; P=.39]	***RVUs per patient*** *September 2012:* 0.0007
			October 2011: 0.0009 % change=7.83 Mean difference=0.00007 95% CI [-0.00003, - 0.00001; P<.01]	*October 2012:* 0.0008
			November 2011: 0.0007 % change=-0.33 Mean difference=0 95% CI [-0.00002, - 0.00002; P=.98]	*November 2012:* 0.0007
			December 2011: 0.0009 % change=-3.45 Mean difference=-0.00003 95% CI [-0.00003, - 0.00006; P=.08]	*December 2012:* 0.0009
Shuaib, 2017[49] Pre-post	NR	NR	***RVUs per patient*** **Mean (SD):** 2.57 (0.84) *Total RVUs per hour (mean, SD):* 241 (3.1 +/- 1.5 per hour)	***RVUs per patient*** **Mean (SD):** 2.74 (0.54) P=.88 *Total RVUs per hour (mean, SD):* 336 (5.2 +/- 1.5 per hour) P<.001

Abbreviations: CI=confidence interval; NR=not reported; NS=non-significant; RCT=randomized controlled trial; RVU=relative value units; SD=standard deviation

APPENDIX 7. CERTAINTY OF EVIDENCE TABLES

Appendix Table 7.1 Certainty of Evidence Tables for Cardiology Studies

Study Risk of Bias	Findings	Sample Size	Study limitations	Directness	Precision	Consistency	Publication Bias	Overall Grade
Patients per hour per clinician								
Bank, 2015[29] Pre-post ROB: Serious	Increase in patients per hour with scribes (2.5 vs 2.3)	N=25 clinicians	Serious	Direct	Imprecise	Unknown	Undetected	Very Low [a,b]
Relative Value Units								
Bank 2015[29] Pre-post ROB: Serious	Increase in financial impacts based on relative value units with scribes versus no scribes (additional revenue of $1,372,694)	N=25 clinicians	Serious	Direct	Imprecise	Unknown	Undetected	Very Low[a,b]

ROB=risk of bias

[a] Downgraded 2 levels for risk of bias
[b] Downgraded 1 level for imprecision (based on unknown magnitudes)

Appendix Table 7.2 Certainty of Evidence Tables for Emergency Department Studies: Randomized Controlled Trials

Study Risk of Bias	Findings	Sample Size	Study limitations	Directness	Precision	Consistency	Publication Bias	Overall Grade
Length of stay								
Walker, 2019[35] RCT ROB: Moderate	Decrease in length of stay with scribes versus no scribes (173 vs 192 minutes)	N=3,885 shifts N=28,936 patients N=88 clinicians	Moderate	Direct	Precise	Unknown	Undetected	Moderate[a]
Patients per hour								
Walker, 2019[35] RCT ROB: Moderate	Increase in patients per hour per clinician with scribes versus no scribes (1.13 [1.11 to 1.17] vs 1.31 [1.25 to 1.38], absolute difference: 0.18 (0.12 to 0.24) increase <0.001)	N=4790 shifts N=28936 patients N=88 clinicians	Moderate	Indirect	Imprecise	Consistent	Undetected	Low[a,b]
Friedson, 2018[45] RCT ROB: Moderate	Increase in patients per shift with scribes versus no scribes (18.6 vs 17.8, difference 0.80, p<.05)							
Relative value units								
Friedson, 2018[45] RCT ROB: Moderate	No difference in relative value units per shift (MD=2.14) but an increase in trimmed relative value units per shift (MD=4.87) with scribes versus no scribes	N=905 shifts	Moderate	Direct	Precise	Unknown	Undetected	Moderate[a]

MD=mean difference; RCT=randomized controlled trial; ROB=risk of bias

[a]Downgraded one level for risk of bias
[b]Downgraded one level for imprecision, difficult to interpret based on the variability in the reporting of the effects

Appendix Table 7.3 Certainty of Evidence Tables for Emergency Department Studies: Observational Studies

Study Risk of Bias	Findings	Sample Size	Study limitations	Directness	Precision	Consistency	Publication Bias	Overall grade
Length of Stay								
Allen, 2014[42] Pre-post ROB: Serious	Decrease in length of stay with scribes versus no scribes (233 vs 249 minutes)							
Arya, 2010[43] Pre-post ROB: Moderate	No difference with scribes versus no scribes							
Bastani, 2014[44] Pre-post ROB: Serious	Decrease in length of stay with scribes versus no scribes (269 vs 289 minutes)							
Heaton, 2016[36] Pre-post ROB: Serious	Increase in length of stay with scribes versus no scribes (265 vs 255 minutes)	N=1,042 shifts						
Heaton, 2017a[37] Pre-post ROB: Moderate	No difference with scribes versus no scribes	N=49,445 patients N=23,319 encounters N=103 clinicians	Serious	Direct	Imprecise	Inconsistent	Undetected	Very Low[a,b,c]
Heaton, 2019a[41] Pre-post ROB: Serious	No difference with scribes versus no scribes							
Hess, 2015[47] Pre-post ROB: Serious	No difference with scribes versus no scribes							
Shuaib, 2017[49] Pre-post ROB: Serious	Decrease in length of stay with scribes versus no scribes (287 vs 303 minutes)							
Walker, 2016a[31] Pre-post ROB: Serious	No difference with scribes versus no scribes							
Patients per hour								
Allen, 2014[42] ROB: Serious	No difference with scribes versus no scribes	N=138 providers	Serious	Direct	Imprecise	Inconsistent	Undetected	Very Low[a,b,c]

Arya, 2010[43] ROB: Moderate	Increase in patients per hour with scribes (0.08 for every 10% increment of scribe usage during a shift)	N=401 shifts N=10531 patients						
Graves, 2018[46] ROB: Serious	Increase in patients per hour with scribes (2.81 vs 2.49)	N=26319 encounters						
Heaton, 2016[36] ROB: Serious	No difference with scribes versus no scribes							
Hess, 2015[47] ROB: Serious	No difference with scribes versus no scribes							
Shuaib, 2017[49] ROB: Serious	Increase in patients per hour with scribes (3.2 vs 2.3)							
Walker, 2016a[31] ROB: Serious	Increase in patients per hour with scribes (1.13 vs 1.02)							
Patient satisfaction								
Bastani, 2014[44] ROB: Serious	Increase in patient satisfaction with scribes versus no scribes	N=799 shifts N=6559 patients N=23,319 encounters N=5 clinicians	Serious	Direct	Imprecise	Consistent	Undetected	Very low[a,b]
Shuaib, 2017[49] ROB: Serious	No difference with scribes versus no scribes							
Walker, 2016a[31] ROB: Serious	No difference with scribes versus no scribes							
Dunlop, 2018[17] ROB: Serious	No difference with scribes versus no scribes							
Provider Satisfaction								
Allen, 2014[42] ROB: Serious	No difference with scribes versus no scribes	N=799 shifts N=30,682 patients N=23,319 encounters N=155 clinicians	Serious	Direct	Imprecise	Inconsistent	Undetected	Very low[a,b,c]
Bastani, 2014[44] ROB: Serious	Increase in provider satisfaction with scribes versus no scribes							
Hess, 2015[47] ROB: Serious	No difference with scribes versus no scribes							
Ou, 2017[48] ROB: Serious	No difference with scribes versus no scribes							

Shuaib, 2017[49] ROB: Serious	Increase in provider satisfaction with scribes versus no scribes							
Walker, 2016b[32] ROB: Serious	No difference with scribes versus no scribes							
Relative Value Units								
Arya, 2010[43] ROB: Moderate	Increase in relative value units per hour with scribes versus no scribes (MD=0.24)	N=1,050 shifts N=4,629 patients N=63,245 encounters N=103 clinicians	Serious	Direct	Precise	Consistent	Undetected	Low[a]
Heaton, 2017b[38] ROB: Serious	Increase in relative value units per patient with scribes versus no scribes (4.04 vs 3.84)							
Heaton, 2019a[41] ROB: Serious	No difference in mean relative value units per hour and patient with scribes versus no scribes (4.79 vs 4.72)							
Hess, **2015**[47] ROB: Serious	Increase in relative value units per hour and patient with scribes versus no scribes							
Shuaib, **2017**[49] ROB: Serious	Increase in relative value units per hour and patient with scribes versus no scribes (241 vs 336)							

ROB=risk of bias

[a]Downgraded 2 levels for risk of bias
[b]Downgraded 1 level for imprecision, difficult to interpret based on the variability in the reporting of the effects
[c]Downgraded 1 level for inconsistency