The Effect of Medical Scribes in Cardiology, Orthopedic, and Emergency Departments: A Systematic Review

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PREFACE

The VA Evidence Synthesis Program (ESP) was established in 2007 to provide timely and accurate syntheses of targeted health care topics of importance to clinicians, managers, and policymakers as they work to improve the health and health care of Veterans. These reports help:

- Develop clinical policies informed by evidence;
- Implement effective services to improve patient outcomes and to support VA clinical practice guidelines and performance measures; and
- Set the direction for future research to address gaps in clinical knowledge.

The program is comprised of three ESP Centers across the US and a Coordinating Center located in Portland, Oregon. Center Directors are VA clinicians and recognized leaders in the field of evidence synthesis with close ties to the AHRQ Evidence-based Practice Center Program and Cochrane Collaboration. The Coordinating Center was created to manage program operations, ensure methodological consistency and quality of products, and interface with stakeholders. To ensure responsiveness to the needs of decision-makers, the program is governed by a Steering Committee comprised of health system leadership and researchers. The program solicits nominations for review topics several times a year via the program website.

Comments on this evidence report are welcome and can be sent to Nicole Floyd, Deputy Director, ESP Coordinating Center at Nicole.Floyd@va.gov.

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This report is based on research conducted by the Evidence Synthesis Program (ESP) Center located at the **Minneapolis VA Health Care System, Minneapolis, MN**, funded by the Department of Veterans Affairs, Veterans Health Administration, Health Services Research and Development. The findings and conclusions in this document are those of the author(s) who are responsible for its contents; the findings and conclusions do not necessarily represent the views of the Department of Veterans Affairs or the United States government. Therefore, no statement in this article should be construed as an official position of the Department of Veterans Affairs. No investigators have any affiliations or financial involvement (*eg*, employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties) that conflict with material presented in the report.

ACKNOWLEDGMENTS

This topic was developed in response to a nomination by Storm Morgan, Program Manager, Office of Nursing Services, on behalf of the Section 507 Committee, for the purpose of informing the Section 507 Committee on the effect of medical scribes in cardiology, orthopedic, or emergency department clinics. This report will be used in conjunction with an evaluation to a pilot on the effects of medical scribes which was mandated by Section 507 of the MISSION Act. The scope was further developed with input from the topic nominators (*ie*, Operational Partners), the ESP Coordinating Center, the review team, and the technical expert panel (TEP).

In designing the study questions and methodology at the outset of this report, the ESP consulted several technical and content experts. Broad expertise and perspectives were sought. Divergent and conflicting opinions are common and perceived as healthy scientific discourse that results in a thoughtful, relevant systematic review. Therefore, in the end, study questions, design, methodologic approaches, and/or conclusions do not necessarily represent the views of individual technical and content experts.

The authors gratefully acknowledge the following individuals for their contributions to this project:

Operational Partners

Operational partners are system-level stakeholders who have requested the report to inform decision-making. They recommend Technical Expert Panel (TEP) participants; assure VA relevance; help develop and approve final project scope and timeframe for completion; provide feedback on draft report; and provide consultation on strategies for dissemination of the report to field and relevant groups.

Storm Morgan, MSN, MBA, RN
Program Manager
Office of Nursing Services

Technical Expert Panel (TEP)

To ensure robust, scientifically relevant work, the TEP guides topic refinement; provides input on key questions and eligibility criteria, advising on substantive issues or possibly overlooked areas of research; assures VA relevance; and provides feedback on work in progress. TEP members are listed below:

Steve Pizer, PhD
Chief Economist, Partnered Evidence-Based Policy Resource Center
Director of Health Law, Policy and Management, Boston University
Boston, MA

Max Napolitano, MPAS
Medical Scribe and Medical Scribe Trainer (former), North Memorial Medical Center
Minneapolis, MN

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Peer Reviewers

The Coordinating Center sought input from external peer reviewers to review the draft report and provide feedback on the objectives, scope, methods used, perception of bias, and omitted evidence. Peer reviewers must disclose any relevant financial or non-financial conflicts of interest. Because of their unique clinical or content expertise, individuals with potential conflicts may be retained. The Coordinating Center and the ESP Center work to balance, manage, or mitigate any potential nonfinancial conflicts of interest identified.

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EXECUTIVE SUMMARY

INTRODUCTION

Medical scribes are individuals who assist clinicians with day-to-day tasks including recording and documenting information in real-time during patient visits.[1,2] In addition to documenting medical visits, medical scribe duties include communicating with patients and completing clerical tasks; verifying and correcting mistakes or inconsistencies in medical records; collecting, organizing, and cataloging data for clinicians; and attending practice-related training. Integrating medical scribes with clinicians is suggested to improve access, quality and timeliness of care, enhance patient and clinician satisfaction and increase productivity and health system revenue.[3-5]

Medical scribe use has increased markedly in the past 10 years, in part, due to implementation of Electronic Medical Records (EMRs) required by legislation. In 2009 the Health Information Technology for Economic and Clinical Health (HITECH) Act, part of the American Recovery and Reinvestment Act (ARRA), was enacted and required meaningful use of health information technology.[2] These acts created a large demand for electronic data entry by clinicians as well as an increase in documentation requirements for billing and reporting initiatives.[2]

EMRs provide important advantages, such as structural and process-related benefits[6] and enhanced patient care.[7] However, EMRs increase the burden of clinical documentation, disrupt face-to-face patient encounters,[8] and reduce time available for resident and student training.[9] Additionally, efficiency measures required by the quality reporting program enacted by the Centers for Medicare & Medicaid Services, such as door-to-doctor time or length of stay, has increased pressure on clinicians and health systems to meet these quality metrics.[10]

While formal training, accreditation, and recertification are not required for all scribe positions, there are 2 scribe accreditation programs available in the United States. In addition to "in house" training, health care systems or individual clinical groups can hire outside companies to train, accredit, place, and conduct performance evaluations of scribes and accompanying documentation through contracting mechanisms. These companies can reduce administrative hiring, training, and oversite burden and serve as a resource to replace scribes that have relatively high turnover. Additionally, these companies can also contract for "virtual scribes" whereby the scribes are located "off-site" and conduct their duties through video teleconferencing.[11]

Within the Department of Veterans Affairs, the 2018 MISSION Act aimed to increase Veterans' access to health care. Section 507 of the MISSION Act[12] mandates a 2-year pilot of in-clinic medical scribes in VA specialty clinics and emergency departments to evaluate clinician efficiency, patient volume, and patient satisfaction. With insight from our Operational Partners and Technical Expert Panel members, we conducted a systematic review of medical scribes focused on outpatient emergency, cardiology, and orthopedic departments. The Section 507 Committee will use the findings of this review to inform the use of medical scribes in the VA. In collaboration with stakeholders, the following Key Questions (KQ) were developed:

1. What is the effect of medical scribes in cardiology, orthopedic, or emergency department clinics?

2. How do the effects of medical scribes vary based on differences in compensation structure (*ie*, contracted through vendor or employees of the institution), qualifications (*ie*, training, accreditation, experience), types of entries (*ie*, medical orders, medical history, coding [billing, diagnoses, complexity/comorbidities]), or setting (*ie*, rural, urban, access-challenged)?

METHODS

Data Sources & Searches

We searched MEDLINE, EMBASE, and CINAHL from 2010 through December 2019 using Medical Subject Headings (MeSH) and key words for medical scribes and outcomes of interest.

Study Selection

Eligible citations were screened independently by 2 reviewers using Distiller SR (Distiller SR, Evidence Partners, Ottawa, Canada) with prespecified criteria. Citations moved to full-text review if either reviewer considered the citation eligible. At the full-text review, agreement of 2 reviewers was needed for study inclusion or exclusion; disputes were resolved by discussion with input from a third reviewer, if needed.

We included English language studies comparing participation in a medical scribe program to usual care or no intervention. Only adult patients and/or practitioners in cardiology, orthopedic, or emergency departments were considered eligible for inclusion. Eligible studies reported outcomes related to clinic efficiency and productivity, clinician and/or patient satisfaction, financial impacts, or quality of documentation.

Data Abstraction & Study Quality Assessment

We abstracted study design and demographic data from eligible studies with low, moderate, or serious risk of bias (ROB) including scribe duties, clinician and scribe experience, scribe training, age, gender, number of patients admitted (for emergency department studies), and funding source. We also abstracted outcomes of interest as described above.

For observational studies we formally assessed ROB for each individual study by assessing critical elements using the ROBINS-I tool.[13] For randomized controlled trials we assessed critical elements using a modified Cochrane tool.[14]

Data Synthesis & Analysis

Due to heterogeneity of populations and interventions, data were not pooled, but narratively synthesized. Tables were developed by outcome and stratified by clinical setting (*ie,* cardiology or emergency department). For Key Question 2, our subgroups of interest included: compensation structure (*ie*, contract or direct hire), qualifications, duties and types of entries required, and setting.

For critical outcomes (number of patients seen per hour or shift, length of stay, patient satisfaction, clinician satisfaction, and relative value units) we rated certainty of the evidence (COE) based on study limitations, directness, precision, consistency, and publication bias. Certainty of evidence was rated as high, moderate, low, or very low.

RESULTS

Results of Literature Search

After removing duplicates, we identified 621 citations for title and abstract triage. A hand-search of systematic review bibliographies yielded 2 additional references. We reviewed the full text of 45 articles and identified 22 which met our inclusion criteria.

Twenty of 22 reports (91%) were from emergency departments. Of these, 6 publications (all observational) came from the same group at a Rochester, MN-based health care system and 6 publications (1 RCT, 1 secondary analysis of the RCT data, 4 observational) came from a group based in Australia. The remaining 8 publications consisted of 1 RCT and 7 observational studies. One of these observational studies was conducted in Canada, and the remaining observational studies and the RCT were conducted in the US.

Two observational studies from cardiology departments were identified, both from the same group at a Minneapolis, MN health care system. No eligible articles were identified from orthopedic departments. No studies were conducted in VA health care systems.

Summary of Results for Key Questions

Seventeen studies (and both cardiology reports) were rated as having serious or critical risk of bias. All scribe programs were in-clinic rather than virtual. Eighteen studies reported clinic efficiency, 5 patient satisfaction, 5 clinician satisfaction, 16 financial impacts, 3 quality of documentation and 3 cost/time of training. Only 4 reports described 4 out of our 5 outcomes of interest and only 2 reported on 3 outcomes of interest. Definitions of outcomes across studies varied. Most reports analyzed information after scribes had gone through an “in-house” training and orientation program and permitted clinicians to select to participate. Reports describing financial impacts typically based the cost of a scribe program on the hourly wages paid for a scribe, and did not report administrative or supervisory cost, the cost of identifying, hiring, training, supervising, maintaining or replacing scribes, documentation verification costs, or costs related to contracting through outside vendors.

Data to address KQ1 are limited in quality and quantity. We identified no studies from orthopedic clinics. The effect of scribes in cardiology clinics is uncertain and based on a single, serious risk of bias study from a single cardiology clinic.

In emergency departments, medical scribes may increase the number of patients seen per hour (low COE) and probably decrease length of stay (moderate COE). The magnitude of effect is likely small, and efficiency may vary based on the setting and outcomes assessed. Medical scribes may increase revenues or relative value units (RVUs) due to more patients seen per hour (low COE). However, resources to train, staff, maintain, and monitor scribes are substantial and rarely accounted for in these estimations. Financial impacts varied based on how outcomes were measured. Medical scribes may make little to no difference in door-to-room or door-to-provider time, number of patients who left without being seen, and patient or clinician satisfaction, though results were mixed. There were no data on quality of documentation or medical errors or the role of scribes in VA emergency departments.

In cardiology or orthopedic clinics, no studies addressed our KQ2 examining how the effects of medical scribes may vary based on differences in compensation structure (*ie*, contracted through vendor or employees of the institution), qualifications (*ie*, training, accreditation, experience), types of entries (*ie*, medical orders, medical history, coding [billing, diagnoses, complexity/comorbidities]), or setting (*ie*, rural, urban, access-challenged).

The effect of medical scribes on emergency department efficiency is uncertain and may vary based on the clinical training, experience, and area service within the emergency department.

DISCUSSION

Key Findings & Strength of Evidence

Findings from our systematic review on the effects of medical scribes in orthopedic, cardiology, and emergency departments are limited by the quantity and quality of available information. Available information is based from studies mostly rated as having serious risk of bias and of limited applicability to widespread implementation. There are no data in VA health care settings or among Veterans.

We found no data on medical scribes in orthopedic clinics. In cardiology clinics the efficiency, financial productivity, and effect on patient and provider satisfaction of scribe programs is uncertain, with findings based on a single, serious risk of bias study from a cardiology group in the United States that evaluated medical scribes provided by a vendor. In emergency departments, medical scribes may improve efficiency (low COE) and financial productivity (low COE). The magnitude of effect on efficiency is likely small to moderate. Efficiency varies based on the setting, outcomes assessed, and methods for evaluating financial productivity. The effect on costs is difficult to ascertain as complete cost reporting was not provided. Resources required to identify, hire, train, staff, maintain, and monitor a scribe program are expected to be substantial and rarely reported in the literature. Online searches for such costs did not provide data. Thus, net financial impact is not known and likely varies by key assumptions and methods for scribe program development, implementation, and maintenance. There are no direct comparative data on quality of documentation, medical errors, or scribe training (*eg,* time to train, turnover), and no data comparing these outcomes in contracted (*ie*, vendor supplied) scribes versus scribes trained “in-house” or using “virtual scribes”.

Additional information on the role of medical scribes in primary care and other specialty settings was beyond the scope of our report and not included. However, these studies are typically of similar methodological quality to those identified in our report – that is, single site reports with clinician volunteers, vendor-supplied scribes, and limited outcome (including financial) reporting. Their results suggest modest effects for improving documentation time and patient satisfaction.[15] It is not known how the results from these settings can be applied to future implementation in orthopedic, cardiology, and emergency departments or in Veterans Affairs Medical Centers. A prior systematic review identified 5 studies published through 2014 and noted limited quality and quantity of information.[16]

Applicability

Current findings have limited applicability and raise important questions about implementation, research gaps, and future research. Despite information that there may be 100,000 medical

scribes in the US in 2020,[17] there is a paucity of data on the effectiveness, harms, costs, and quality of scribes, or on best methods for implementation and evaluation. No studies were conducted in Veterans Affairs Medical Centers and the effectiveness and financial productivity for widespread implementation across a national health care system are not known. Several reports were not from the US, and many evaluated programs after training had been completed and limited inclusion to clinicians volunteering for scribe services. Additionally, a large amount of information was reported from 2 emergency department groups, 1 in Australia. The only report from a cardiology department was limited to a single clinic in the US that assigned scribes to clinician volunteers and altered the daily schedule of clinicians working with scribes to permit more clinic visits. Scribes in the cardiology report were hired by an outside vendor and had extensive experience. Charges and costs for the services provided by the vendor were not described. None of the programs described the possible role of allocating scribe services to employees currently assigned other clinic duties, including administrative, nursing, or "clinician extenders". The effect of scribes on improving efficiency, patient access, and throughput likely also requires additional programmatic factors including reducing clinic appointment times and increasing the number of patients scheduled per day.

Research Gaps & Future Research

Our principal finding is that there are large gaps in evidence that require future research. Despite the marked increase in the use of medical scribes in the United States there is no high-quality information evaluating their effects on clinic efficiency, health care access, patient or clinician satisfaction, or financial investment and productivity in cardiology, orthopedic, and emergency departments. There are no data on the use of virtual scribes. Additionally, there are limited data on other important aspects of a medical scribe program, including documentation quality, the comparative effects of in-house versus contracted hiring, training, maintaining, and/or supervising, large-scale implementation of medical scribes, and other components of medical scribe programs required to enhance care quality, including productivity. Data from other clinical settings (primary care and other specialty clinics) are of limited applicability, quality, and quantity.

Policy Implications

Our results have policy implications and suggest that prior to widespread implementation, more information is needed on the effectiveness, harms, and costs of scribe programs. If information is deemed sufficient for programmatic rollout, then clear identification and evaluation of programmatic goals (improving access and patient/provider satisfaction, enhancing documentation quality, increasing clinical throughput), resources, programmatic models, and personnel required, as well as implementation barriers and facilitators, are needed.

Conclusions

Based on mostly serious risk of bias reports, in-person medical scribes may improve clinic efficiency and improve financial productivity and revenue as measured by relative value units in emergency departments. The effects on clinic efficiency appear to be small in magnitude and dependent on the type and method of outcome assessment. Cost and financial productivity data do not include the cost of hiring, training, maintaining, and supervising scribes. Generalizability of findings outside the reported settings is limited. The effect of medical scribes in cardiology departments is uncertain. There is no information from orthopedic departments, VA Medical

Centers, or on virtual scribes. There is little information on patient or clinician satisfaction, scribe documentation quality, or whether results vary by in-house versus contracted hiring and training.

ABBREVIATIONS TABLE

Abbreviation	Definition
ARRA	American Recovery and Reinvestment Act
CI	Confidence interval
CMS	Centers for Medicare and Medicaid Services
COE	Certainty of evidence
ED	Emergency department
EMR	Electronic Medical Record
ESP	Evidence Synthesis Program
GRADE	The Grading of Recommendations Assessment, Development and Evaluation Approach
HITECH	Health Information Technology for Economic and Clinical Health Act
KQ	Key Question
MD	Mean difference
MeSH	Medical subject heading
RCT	Randomized controlled trial
ROB	Risk of bias
RVU	Relative value units
TEP	Technical expert panel
US	United States of America
VA	Department of Veterans Affairs

EVIDENCE REPORT

INTRODUCTION

Medical scribes are individuals who assist health care clinicians (physicians, nurse practitioners, and physician assistants) with day-to-day tasks including recording and documenting information in real-time during patient visits.[1,2] In addition to documenting medical visits, primary medical scribe duties and responsibilities include communicating with patients and completing clerical tasks; verifying and correcting mistakes or inconsistencies in medical records; collecting, organizing, and cataloging data for clinicians; and attending trainings related to practice.[1] Medical scribes are most commonly unlicensed individuals with a health-degree focus[2]; however, accreditation programs do exist. Integrating medical scribes with clinicians is suggested to improve access, quality and timeliness of care, enhance patient and clinician satisfaction, and increase clinician productivity and health system revenue.[3-5]

Medical scribe use has increased markedly in the past 10 years making it the fastest-growing health care profession in the United States.[2] This increase is believed to result, in part, from implementation of Electronic Medical Records (EMRs) required by legislation. In 2009 the Health Information Technology for Economic and Clinical Health (HITECH) Act, part of the American Recovery and Reinvestment Act (ARRA), was enacted and required meaningful use of health information technology.[2] These acts created a large demand for electronic data entry by health care clinicians as well as an increase in documentation requirements for billing and reporting initiatives.[2]

EMRs provide important advantages, such as structural and process-related benefits[6] and enhanced patient care.[7] However, EMRs increase the burden of clinical documentation, disrupt face-to-face encounters with patients,[8] and reduce time available for resident and student training.[9] Additionally, efficiency measures required by the quality reporting program enacted by the Centers for Medicare & Medicaid Services (CMS), such as door-to-doctor time or length of stay, have increased pressure on clinicians and health systems to meet these quality metrics.[10]

While formal training, accreditation, and recertification are not required for all scribe positions, there are 2 scribe accreditation programs in the United States from the American College of Medical Scribe Specialist and the American Healthcare Documentation Professional Group. Both accreditation programs test aspiring scribes on competencies related to care and require completed pre-clinical training as well as clinical training hours.[18,19] The American College of Medical Scribe Specialists is also certified by CMS and emphasizes CMS reporting in the training.[20] Both programs require re-training and licensing every 12-24 months.

Scribes are typically hourly employees with wages ranging from $10 to $21 per hour.[21] Costs to consider before implementing a scribe program may include salary, taxes, and benefits. Although some larger scribe vendors may provide health insurance, many individual clinicians and health institutions do not.[22] When implementing scribes though in-house hiring and training programs, previous studies have put internal recruitment costs of scribes around $3,117 per scribe and additional training costs around $1,200.[23]

Alternatively, contracting scribes through external vendors is also an option. Companies can be hired by health care systems or individual clinical groups to train, accredit, place, and conduct performance evaluations of scribes through contracting mechanisms to health care systems. These companies can reduce administrative hiring, training, and oversight burden to health care facilities and serve as a resource to replace scribes due to relatively high turnover. Additionally, these companies can also contract for "virtual scribes" whereby the scribes are located "off-site" and conduct their duties through video teleconferencing.[11] To date there is little non-industry evidence comparing benefits, harms, and costs of contract (*ie*, vendor-supplied) scribes to those which are employees of the institution.

Within the Department of Veterans Affairs, the 2018 MISSION Act aimed to increase Veterans access to health care in VA facilities and the community. Section 507 of the MISSION Act[12] mandates a 2-year pilot of in-clinic medical scribes in VA specialty clinics and emergency departments across the United States. The pilot will evaluate clinician efficiency, patient volume, and patient satisfaction.

We conducted a systematic review of the effects of medical scribes. With insight from our operational partners and technical expert panel members, our scope focused on outpatient emergency, cardiology, and orthopedic departments. The Section 507 Committee will use the findings of this review alongside findings from the medical scribe pilot to inform the use of medical scribes in VA including considerations of budgeting, resource utilization, and services where medical scribes may be most beneficial.

METHODS

TOPIC DEVELOPMENT

Section 507 of the 2018 VA MISSION Act has mandated a 2-year medical scribes pilot in specialty and emergency departments within VA. This pilot will evaluate the impact of medical scribes on clinician efficiency, patient volume, and patient satisfaction within cardiology, orthopedic, and emergency department clinics. This review was convened to supplement findings from this pilot to inform future use of medical scribes in VA. Key Questions (KQ) were developed in collaboration with stakeholders from the VA Office of Nursing Services, along with our technical expert panel.

1. What is the effect of medical scribes in cardiology, orthopedic, or emergency department clinics?

2. How do the effects of medical scribes vary based on differences in compensation structure (*ie*, contracted through vendor or employees of the institution), qualifications (*ie*, training, accreditation, experience), types of entries (*ie*, medical orders, medical history, coding [billing, diagnoses, complexity/comorbidities]), or setting (*ie*, rural, urban, access-challenged)?

A protocol was developed with input from stakeholders and our Technical Expert Panel and registered in PROSPERO (CRD42020169079).

DATA SOURCES & SEARCHES

We searched MEDLINE, EMBASE, and CINAHL from 2010 through December 2019 using Medical Subject Headings (MeSH) and keywords for medical scribes and outcomes of interest (Appendix 1). We supplemented these results with additional searches of bibliographies from recent systematic reviews, and references from our technical expert panel.

STUDY SELECTION

Eligible citations were screened independently by 2 reviewers using Distiller SR (Distiller SR, Evidence Partners, Ottawa, Canada) with prespecified criteria. Citations moved to full-text review if either reviewer considered the citation eligible. At full-text review, agreement of 2 reviewers was needed for study inclusion or exclusion; disputes were resolved by discussion with input from a third reviewer, if needed.

We included English-language intervention studies, interrupted time series or other pre-post studies, and observational studies comparing participation in a medical scribe intervention to usual care or no intervention. Only adult patients and/or practitioners in cardiology, orthopedic, or emergency departments were considered eligible for inclusion. Eligible interventions consisted of a “medical scribe” or “document assistant” program that involved navigation of an electronic health record system and provided some information about scribe responsibilities/duties. Eligible studies reported outcomes related to clinic efficiency (*eg,* patients seen per hour, length of stay), clinician and/or patient satisfaction, financial impacts (*eg,*

revenues, cost of scribes), quality of documentation, medical errors, or scribe training (*eg,* time to train, turnover). A full list of inclusion/exclusion criteria can be found in Appendix 2.

DATA ABSTRACTION & STUDY QUALITY ASSESSMENT

We formally assessed risk of bias (ROB) of each individual study by assessing critical elements using the ROBINS-I tool[13] for observational studies and a modified Cochrane tool[14] for randomized controlled trials (RCTs), as described in Appendix 3. Two reviewers independently rated each non-randomized eligible study as low, moderate, serious, or critical ROB, and randomized studies were rated as low, moderate, or high ROB. Consensus was reached through discussion, if necessary. Studies rated as critical or high ROB were not included for analysis. Ratings for each study can be found in Appendix 4.

We abstracted data from all eligible studies with low, moderate, or serious ROB on: design and description of study; health care setting (rural, urban, access-challenged); scribe duties (types of entries); clinician and scribe experience; scribe training and/or accreditation (hours of training and whether training was in-house or contracted by a vendor); quality of documentation and/or medical errors; baseline characteristics including age, gender; number of patients admitted (for emergency department studies); funding source; and all data related to outcomes of interest (*ie*, clinic efficiency, patient/clinician satisfaction, and financial impacts). For clinic efficiency, we abstracted number of patients seen per hour or shift, door-to-room time, door-to-provider time, length of appointments, length of stay/door-to-disposition time, and number of patients who left without being seen (for emergency room studies). For financial productivity we abstracted revenues and costs related to scribe training.

We also abstracted relative value units (RVUs), which are a measure of physician and health system productivity and used by Medicare for reimbursement. Each medical procedure has a number of RVUs associated with it, and payment per RVU can vary depending on a number of factors, such as the local price level and the local malpractice environment. In 2020, the monetary value to be reimbursed per RVU was $36.0896.[24]

DATA SYNTHESIS & ANALYSIS

Due to heterogeneity of populations and interventions, data were not pooled but narratively synthesized. Tables were developed by outcome and stratified by clinical setting (*ie,* cardiology or emergency department). For Key Question 2, our subgroups of interest included: compensation structure (*ie*, contracted through a vendor or employee of the institution), qualifications, duties and type of entry required, and setting.

Overall quality of evidence for the primary outcomes considered ‘critical’ (important for decision making) within each comparison was evaluated using a modified Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach on 5 assessed domains.[25] The quality of evidence levels range from high to very low (Table 1). The 5 domains include: (1) study limitations (risk of bias); (2) directness (single, direct link between intervention and outcome); (3) consistency (similarity of effect direction and size among studies); (4) precision (degree of certainty around an estimate [*ie*, width of confidence intervals]); and (5) publication bias. In the GRADE approach, the initial quality of evidence is considered high for RCTs and low for observational studies.[26,27] Our summary of assessment of

"effectiveness" is based on statistical significance of the effects rather than an established or derived clinical magnitude of importance or estimates of precision derived from confidence intervals.

We graded certainty of evidence for the following outcomes that we deemed critical to decision making: patients seen per hour, length of stay, patient satisfaction, clinician satisfaction, and RVUs.

Table 1. GRADE Quality of Evidence

GRADE Quality of Evidence Levels	
Quality Level	**Definition**
High	We are very confident that the true effect lies close to that of the estimate of the effect.
Moderate	We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that is substantially different.
Low	Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect.
Very Low	We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of the effect.

PEER REVIEW

A draft version of this report was reviewed by 4 technical experts and VA operational partners. Their comments and our responses are presented in Appendix 5.

RESULTS

After removing duplicates, we identified 621 citations for title and abstract triage. A hand-search of systematic review bibliographies yielded 2 additional references. We reviewed the full text of 45 articles and identified 22 which met our inclusion criteria (Figure 1).

Of the eligible articles, we identified 2 observational studies from cardiology departments, both from the same group at a Minneapolis, MN-based health care system. No eligible articles were identified from orthopedic departments. (Table 2)

All but 2 eligible articles (20/22, 91%) were from emergency departments. Of these, 6 publications (all observational) came from the same group at a Rochester, MN-based health care system and 6 publications (1 RCT, 1 secondary analysis of the RCT data, 4 observational) came from a group based in Australia. The remaining 8 publications consisted of 1 RCT and 7 observational studies. One of these observational studies was conducted in Canada, and the remaining observational studies and RCT were conducted in the US. Summary characteristics of eligible publications can be found in Table 2.

Eighteen studies reported clinic efficiency, 5 patient satisfaction, 5 clinician satisfaction, 8 for financial productivity, 10 on relative value units (RVUs), 3 for quality of documentation, and 3 for cost/time of training. Only 4 reports noted 4 out of our 5 outcomes of interest and only 2 reported on 3 outcomes of interest. (Table 3) Our summary of assessment of “effectiveness” is based on statistical significance of the effects rather than an established or derived clinical magnitude of importance or estimates of precision derived from confidence intervals.

Most authors (8/12) reported using a vendor service which supplied, trained, and managed scribes. One Australian group used a vendor service for a pilot study (1 publication) and then implemented an in-house scribe program (4 publications). Two US-based groups implemented an in-house scribe program (6 publications from one group and 1 publication from another). One publication did not report any information on scribe training. The remaining 9 publications used a vendor service. While most publications (18/22) reported on components of how scribes were trained (*eg,* on-site training or classroom lecture), very few provided details about training programs or costs associated with training. Few studies reported scribe experience at baseline. No studies reported associated and peripheral costs with employing scribes (administration or management) or elements such as scribe turnover. All programs utilized “in person” rather than virtual or tele-scribes.

Five studies (including both RCTs) were rated as moderate ROB and 15 studies were rated as serious ROB. Two studies were rated as critical risk of bias and not analyzed further.

Figure 1. Literature Flow

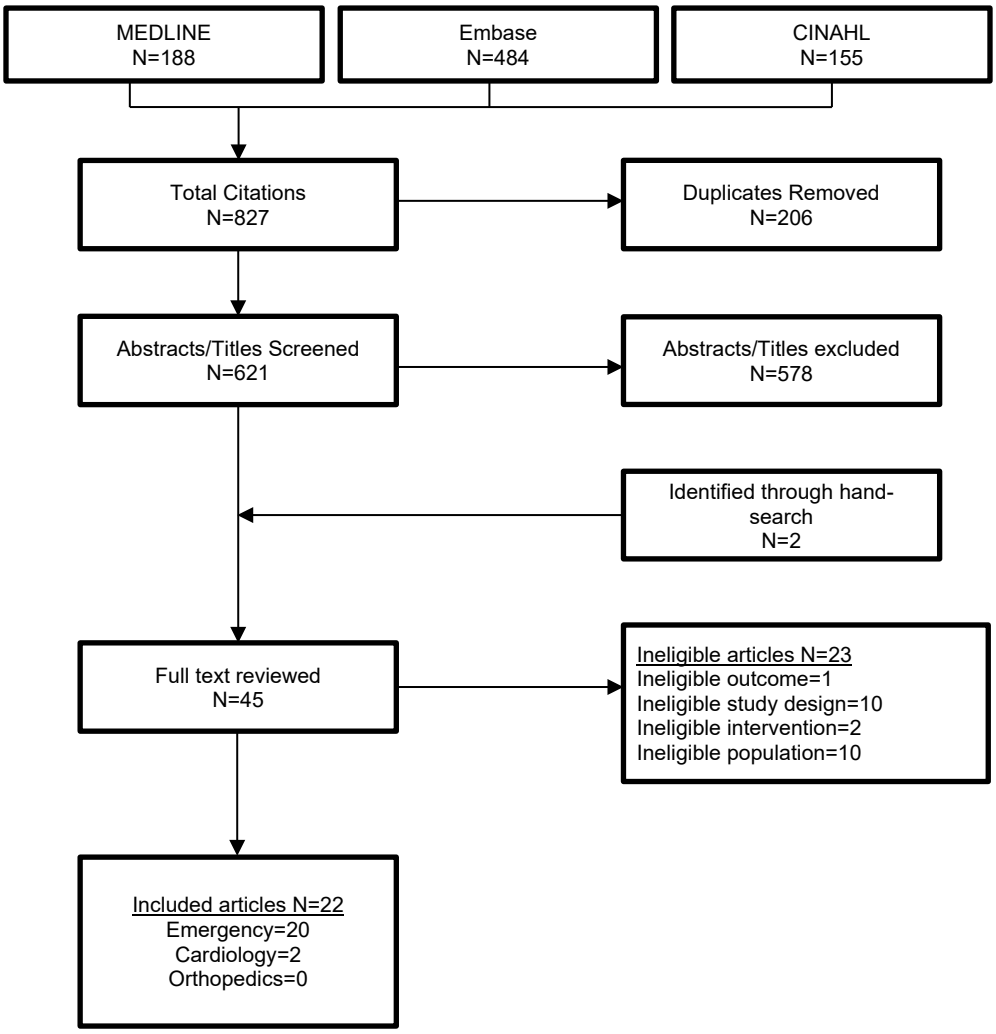

Table 2. Summary characteristics of all eligible publications

Author, Year	Risk of Bias	Location	Outcomes Reported						
			Clinic Efficiency (k=18)	Patient Satisfaction (k=5)	Clinician Satisfaction (k=5)	Financial productivity (k=8)	Relative Value Units (k=10)	Quality of Documentation (k=3)	Cost/Time of Training (k=3)
Orthopedics									
No eligible studies identified									
Cardiology									
Bank, 2013[28]	Critical	United States	X	X		X	X		
Bank, 2015[29]	Serious	United States	X			X	X	X	X
Emergency Departments									
Walker, 2014[30]	Critical	Australia	X			X			X
Walker, 2016a[31]	Serious	Australia	X	X	X	X			
Walker, 2016b[32]	Serious	Australia				X			
Walker, 2017[33]	Moderate	Australia						X	
Dunlop 2018[34]	Serious	Australia	X	X					
Walker, 2019*[35]	Moderate	Australia	X			X		X	X
Heaton, 2016[36]	Serious	United States	X				X		
Heaton, 2017a[37]	Serious	United States	X				X		
Heaton, 2017b[38]	Moderate	United States					X		
Heaton, 2018[39]	Serious	United States	X						
Heaton, 2019a[40]	Serious	United States					X		
Heaton, 2019b[41]	Serious	United States	X			X			
Allen, 2014[42]	Serious	United States	X		X				
Arya, 2010[43]	Moderate	United States	X				X		
Bastani, 2014[44]	Serious	United States	X	X					
Friedson, 2018*[45]	Moderate	United States	X				X		
Graves, 2018[46]	Serious	Canada	X			X			
Hess, 2015[47]	Serious	United States	X		X		X		
Ou, 2017[48]	Serious	United States	X		X				
Shuaib, 2017[49]	Serious	United States	X	X	X		X		

*Randomized controlled trial

Table 3. Summary of results for emergency department publications*

Author, Year Risk of Bias	Outcomes									
	Patients per hour per clinician	**Door-to-Room/ Waiting Time (minutes)**	**Door-to-Provider (minutes)**	**Appointment Length/ Time-to-disposition**	**Door-to-Discharge/ LOS (minutes)**	**LWBS**	**Patient Satisfaction**	**Clinician Satisfaction**	**Financial Productivity**	**Relative Value Units (RVU)**
Walker, 2016a[31] Serious	↑ 1.13 vs 1.02	NR	↔	NR	↔	NR	↔	↔	↔[h]	NR
Walker, 2019[35] Moderate	↑ 1.31 vs 1.13	NR	↔	NR	↓ 173 vs 192	NR	NR	NR	↑[i] -$26.15/hr	NR
Dunlop 2018[34] Serious	NR	NR	↔	NR	NR	NR	↔	NR	NR	NR
Heaton 2016[36] Serious	↔	NR	↔	↔	↑ 265 vs 255	NR	NR	NR	NR	NR
Heaton 2017a[37] Serious	NR	NR	↔	↔	↔	NR	NR	NR	NR	NR
Heaton 2017b[38] Moderate	NR	NR	NR	NR	NR	NR	NR	NR	NR	↑[k] 4.04 vs 3.84
Heaton 2018[39] Serious	NR	NR	NR	↔	NR	NR	NR	NR	NR	NR
Heaton 2019a[41] Serious	NR	NR	↔	↔	↔	NR	NR	NR	NR	↔[k]
Heaton, 2019b[40] Serious	NR	NR	NR	NR	NR	NR	NR	NR	↑[j] $488 vs $600	NR
Allen, 2014[42] Serious	↔	↔	↔	↓ 157 vs 169	↓ 233 vs 249	↔	NR	+[c]	NR	NR
Arya, 2010[43] Moderate	↑ +1.63[a]	NR	NR	NR	↔	NR	NR	NR	NR	↑[l] +0.24
Bastani, 2013[44]	NR	↓ 34 vs 35	↓ 61 vs 74	↓ 185 vs 237	↓ 269 vs 289	NR	↑[b] 58% vs 75%	↑[d] 62% vs 92%	NR	NR

Serious										
Friedson, 2018[45] Moderate	↑ 2.33 vs 2.23	NR	NR	↓ 228 vs 258	NR	NR	NR	NR	NR	↔[m] ↑[n] 72 vs 77
Graves, 2018[46] Serious	↑ 2.81 vs 2.49	NR	NR	NR	NR	NR	NR	NR	NR	NR
Hess, 2015[47] Serious	↔	NR	NR	NR	↔	↑	NR	+[e]	NR	↔/↑[o]
Ou, 2017[48] Serious	NR	NR	NR	NR	NR	NR	NR	+[f]	NR	NR
Shuaib, 2017[49] Serious	↑ 3.2 vs 2.3	↓ 41 vs 37	↓ 56 vs 61	↓ 228 vs 237	↓ 287 vs 303	NR	↔	↑[g] 66% vs 81%	NR	↔[p] ↑[q] 241 vs 336

↔=no significant difference; ↑=increase in outcome compared to control group; ↓=decrease in outcome compared to control group; +=satisfaction reported, but no comparison group; LOS=length of stay; LWBS=left without being seen; NR=not reported; RVU=relative value units

*Numerical data only presented when deemed statistically significant

[a] Calculated by ESP team, unable to calculate for comparison group

[b] Press Ganey Survey: Overall patient satisfaction percentiles

[c] 100% clinicians reported "scribes are a valuable addition"; 77% clinicians reported "scribes increase workplace satisfaction; 90% clinicians reported "scribes increase quality of life"

[d] Press Ganey Survey: Overall physician satisfaction percentiles

[e] 62% clinicians "liked or loved working with scribes", 74% clinicians "positive or very positive attitude towards scribes", 82% clinicians "positive or very positive changes in efficiency"

[f] 85% residents "my interactions with attendings have improved with scribes", 79% "scribes have improved my overall education as a resident in the emergency department"

[g] "Physician satisfaction increased 15% from pre- to post-scribe" (p=NR)

[h] Billing per patient

[i] "Cost saving to the hospital per scribed hour of $26.15 when hospital absorbs the cost of training"

[j] estimated costs of charting per shift

[k] mean RVUs per patient

[l] RVUs per hour increased by 0.24 units for every 10% increment in scribe usage during a shift

[m] total RVUs per shift

[n] trimmed RVUs per shift (lowest and highest 10% removed from analysis)

[o] Pre-post differences in seasonally-matched productivity metrics; mean differences in RVU per patient and RVU per hour were mixed

[p] mean RVUs per patient

[q] mean total RVUs per hour

KEY QUESTION 1A: WHAT IS THE EFFECT OF MEDICAL SCRIBES IN ORTHOPEDIC CLINICS?

We identified no eligible studies that examined the effect of medical scribes in orthopedic clinics.

KEY QUESTION 1B: WHAT IS THE EFFECT OF MEDICAL SCRIBES IN CARDIOLOGY CLINICS?

Key Messages

- In cardiology clinics, the effect of medical scribes on efficiency and financial productivity is uncertain.
- There are no data on medical errors or scribe training (*eg*, time to train, turnover).
- Resources required to train, staff, maintain, and monitor scribes are substantial and rarely reported.
- There are no data on the role of scribes in VA cardiology clinics.

We identified 2 eligible studies that examined the effect of medical scribes in cardiology clinics.[28,29] Both studies were conducted by the same group at a single center in St. Paul, Minnesota. One of these studies was rated critical ROB and not analyzed further.[28] Detailed ROB assessments can be found in Appendix 4.

Bank et al[29] performed a retrospective study comparing routine clinic visits of 10 cardiologists with scribes to 15 cardiologists without scribes. 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, in routine and scribe clinics respectively.

Scribes received approximately 184 hours of total training, including classroom lecture, supervised on-floor training, and cardiology-specific terminology and clinic processes from an outside "scribe vendor" hired to perform these services and provide ongoing monitoring and retention. Scribe duties included medical documentation services and clerical support.

Summary results are presented in Table 4. Detailed study characteristics and results can be found in Appendix Table 6-1 and Appendix Table 6-2, respectively. Certainty of evidence tables can be found in Appendix 7.

Table 4. Summary results for cardiology studies

Author, Year Risk of Bias	Study Characteristics (Sample size)	Outcomes				
		Patients/hour per clinician	Patient Satisfaction	Clinician Satisfaction	Financial productivity	Relative Value Units
Bank, 2015[29] Serious	Retrospective observational N=25 providers	↑ 2.5 vs 2.3	NR	NR	↑	↑[a]

↑=increase in outcome compared to control group; ↓=decrease in outcome compared to control group; **NR**=not reported
[a] work based on Relative Value Units

Clinic Efficiency

Bank et al[29] reported that physicians who had a scribe, and were thus scheduled for more patients per day (24 vs 22), saw more new (84) and returning (423) patients annually, but did not report any tests of statistical significance. Physicians with scribes saw 9.6% more patients per hour (2.5 vs 2.3) when compared to physicians without scribes (P=.01); however, by design scheduling templates for physicians with scribes allowed for more appointments.

Patient/Clinician Satisfaction

No studies assessed patient or clinician satisfaction.

Health Care and System Outcomes

Financial Productivity and Relative Value Units

Bank et al[29] reported the use of scribes was associated with more patients seen annually, and an increase in work RVUs. Scribes' clinic notes were coded and billed at a higher level. The study estimated an "additional annual revenue of $1,372,694 at a cost [for the scribes' salary] of $98,588." No data were provided on the costs paid to the vendor or other administrative or operating costs. The lead author was noted to be a paid consultant to 2 different scribe vendors, though not the vendor used for this study.

Quality of Documentation

While Bank et al[29] did not formally evaluate the quality of documentation, they stated "the higher level of service associated with visits using a scribe suggests that documentation may be better during those visits."

KEY QUESTION 1C: WHAT IS THE EFFECT OF MEDICAL SCRIBES IN EMERGENCY DEPARTMENTS?

Key Messages

- The quality, quantity, completeness, and applicability of findings is limited.
- Medical scribes may improve efficiency by increasing number of patients seen per hour (low certainty of evidence [COE]) and decreasing length of stay (moderate COE). The magnitude of effect is likely small; efficiency may vary based on the setting and outcomes assessed.
- Medical scribes may increase revenues or RVUs due to more patients seen per hour (low COE); however, resources required to train, staff, maintain, and monitor scribes are substantial and rarely accounted for in these estimations.
    - Financial impacts varied based on how outcomes were measured.
- In emergency departments, medical scribes may make little to no difference in door-to-room or door-to-provider time, number of patients who left without being seen, and patient or clinician satisfaction, though results were mixed.

- No comparative reliable data on quality of documentation or medical errors was identified.
- There are no data on the role of scribes in VA emergency departments.

Twenty eligible studies were identified that reported on the effect of medical scribes in emergency departments.[30-49] Six were from one group in Australia,[30-35] 6 from one group in the US,[36-41] and the remaining 8 were from different areas around the US[42-45,47-49] and Canada.[46]

Two RCTs were identified[35,45] and rated as moderate ROB. From the remaining observational studies, 3 were rated moderate ROB,[33,38,43] 15 were rated serious ROB,[29,31-34,36,37,39-42,44,46,48,49] and 2 were rated critical ROB and not analyzed further.[28,30] Outcome reporting was incomplete and varied across studies. For example, no study reported on all our outcomes of interest and few reported on 3 or more. The most commonly reported outcomes were measures of clinic efficiency (16/20 studies), financial productivity (6/20) and RVU (8/20).

Walker et al Group (Victoria, Australia)

Six studies, conducted by the Walker group, were included that assessed outcomes of interest in emergency department clinics. All studies were conducted at a private emergency department (ED) setting in Australia. Cabrini Hospital is a tertiary, non-profit, Catholic private hospital in southeast Melbourne. Therefore, results from this group are likely to be highly correlated across the studies, though are not considered duplicate reporting of results. The emergency department sees approximately 24,000 adult and pediatric patients annually and has a 48% admission rate.

One prospective observational pilot study was conducted in 2013,[30] which was rated critical ROB and omitted for further analysis. An additional prospective pilot study was conducted in 2014,[31] which was rated serious ROB. This study used a single American scribe provided by a scribe company that required 2 years of experience. The third study in this series was an economic evaluation describing the cost to implement an in-house training program, and train Australian scribes, which was rated serious ROB and did not provide any comparison data.[32] A multi-center RCT was then conducted from 2015-2018, using the trained Australian scribes from the economic evaluation discussed previously; it was rated moderate ROB.[35] The RCT was conducted at the same private emergency department, as well as other facilities within the same health care system. During the RCT period, a qualitative interview study was done to assess patient satisfaction, which was rated serious ROB.[34] Using data from the RCT, a secondary analysis was conducted to assess note quality, which was rated moderate ROB.[33]

Detailed ROB assessments can be found in Appendix 4. Summary results for the 3 Walker studies that reported outcomes of interest are presented in Table 5. Detailed study characteristics can be found in Appendix Table 6-3 and detailed results for clinic efficiency, patient and clinician satisfaction, and health care systems outcomes can be found in Appendix Table 6-4, Appendix Table 6-5, and Appendix Table 6-6, respectively. Certainty of evidence tables can be found in Appendix 7.

Table 5. Summary results for emergency department studies (Walker group, Australia)*

Author, Year Risk of Bias Study Characteristics (sample size)	Outcomes									
	Patients per hour per clinician	**Door-to-Room/ Waiting Time (minutes)**	**Door-to-Provider (minutes)**	**Appointment Length/ Time-to-disposition**	**Door-to-Discharge/ LOS (minutes)**	**LWBS**	**Patient Satisfaction**	**Clinician Satisfaction**	**Financial Productivity**	**Relative Value Units**
Walker, 2016a[31] Serious Prospective observational, single center N=5 physicians N=799 shifts N=6344 patients	↑ 1.13 vs 1.02	NR	↔	NR	↔	NR	↔	↔	↔[a]	NR
Walker, 2019[35] Moderate RCT, multi-center N=88 physicians N=3885 shifts N=28936 patients	↑ 1.31 vs 1.13	NR	↔	NR	↓ 173 vs 192	NR	NR	NR	↑[b] -$26.15/hour	NR
Dunlop 2018[34] Serious Semi-structured interview N=215 patients	NR	NR	↔	NR	NR	NR	↔	NR	NR	NR

↔=no significant difference; ↑=increase in outcome compared to control group; ↓=decrease in outcome compared to control group; LOS=length of stay; LWBS=left without being seen; NR=not reported; RCT=randomized controlled trial

*Numerical data only presented when deemed statistically significant

[a] Billing per patient
[b] "Cost saving to the hospital per scribed hour of $26.15 when hospital absorbs the cost of training"

Clinic Efficiency

Patients seen per day

Two studies reported on the number of patients seen per day. One was a single center prospective cohort, rated serious ROB,[31] and the other was a multicenter randomized controlled trial, rated moderate ROB.[35] Both studies reported an increase in the total number of patients seen per hour in the scribe group when compared to the non-scribe group. However, the observational study did not report any tests of statistical significance. The RCT reported that scribes increased the number of patients seen per hour per clinician from 1.13 (95% CI 1.11 to 1.17) to 1.31 (95% CI 1.25 to 1.38), representing a 15.9 percent relative increase (P<0.001).

Door-to-provider time

Three studies reported on door-to-provider time. One was a single center prospective cohort, rated serious ROB,[31] another was a multicenter randomized controlled trial, rated moderate ROB,[35] and the third was a qualitative interview study conducted during the same time period as the RCT.[34] None of these studies reported any significant difference in door-to-provider time in the scribe group compared to the non-scribe group.

Appointment length

None of the Walker et al studies reported on outcomes related to appointment length.

Time-to-disposition

None of the Walker et al studies reported on outcomes related to time-to-disposition.

Length of stay/Door-to-discharge time

Two studies reported on length of stay, though results were mixed. One was a single center prospective cohort, rated serious ROB,[31] and the other was a multicenter randomized controlled trial, rated moderate ROB.[35] The prospective cohort study reported no significant difference in length of stay between the scribe and non-scribe groups. Conversely, the RCT found that the length of stay in the scribe group was reduced by 19 minutes (absolute reduction) when compared to the non-scribe group (P<.001).

Patients left without being seen

None of the Walker et al studies reported on the number of patients who left the emergency department without being seen.

Patient/Clinician Satisfaction

Two studies reported on patient and/or clinician satisfaction. Both were conducted at the same private ED and rated serious ROB. One was a prospective cohort study which reported "*no patients asked the scribe to leave or complained about the scribe's presence*" and "*all physicians were satisfied with the initial history/physical exam capture into the chart and would like a scribe permanently*." However, no formal data collection measures were described.[31]

The second study was a qualitative, semi-structured interview study which reported no differences in patient satisfaction between the scribe and non-scribe groups. This study was conducted during the same time as the aforementioned RCT and consisted of interviewing patients while they were in the waiting room using previously validated questionnaires.[34]

Health Care and System Outcomes

Financial productivity and relative value units

Three studies reported on the financial impacts of implementing a scribe program. Two were single center prospective cohort studies both rated serious ROB,[31,32] and the third was a multi-center RCT rated moderate ROB.[35]

Walker et al 2016a[31] was a pilot study which reported no significant differences in amount billed per patient between the scribe group and the non-scribe group. The scribe group reported an average of billing $150 per patient, while the non-scribe group reported an average of billing $149 per patient. These estimates did not include the cost of the scribe.

Walker et al 2016b[32] was an economic evaluation study conducted to determine the cost of implementing a scribe program. The medical center hired and trained scribes with no previous experience and measured recruitment costs, start-up costs, cost of training materials/courses, and administration costs of their scribe program. They found that scribes required 68-118 hours of training to become competent, and medical students achieved competency faster (after 7 shifts) than premedical students (after 8-16 shifts), and individuals from other disciplines did not achieve competency. The program took 7 months to implement (not including initial stakeholder buy-in time). Out of 79 applicants, 22 were invited to interview, and 10 had successful interviews. From those 10, only 5 (2 medical students and 3 pre-medical students) successfully completed training and became competent scribes.

Costs were reported based solely on a salary for the scribes ($15.91/hour), which included a 25% "on-cost" or "fringe". Costs were reported for the total time it took to implement the scribe program (7 months) and does not include or report the amount of time for initial stakeholder buy-in or cost to replace departing scribes. (Table 6) The study also compared physicians' productivity (based on patients seen per hour) with and without scribe trainees, and found that the productivity of physician trainers was unaffected while training scribes.

Table 6. Reported costs of implementing a scribe program from Walker et al[32]

Component	Total cost (US$)	Total cost per competent scribe[a] (US$)
Recruitment and start-up	15,555	3,111
Education program	6,283	1,257
Administration	4,326	866
Clinical training	5,686	1,137
Total	31,853	6,371

[a] at the end of the implementation, the institution had 5 competent scribes

Walker et al (2019)[35] was a multi-center RCT that used the scribes trained in the previously described economic evaluation[32] and estimated costs during the RCT period. The authors reported that scribes earned $20.51/hour and physicians earned $165/hour; estimating a 15% gain in productivity when a scribe was working generated a savings of $24.75/hour in physician time. The study also reported "training the scribe cost $5015 per scribe, and scribes worked 1000 hours once trained, generating a cost per hour worked of US$5 after completion of training."

Quality of documentation

No study directly reported on quality of documentation.

However, 1 multicenter moderate ROB RCT[35] reported 16 "incidents" (possibly attributed to the scribe) where the scribe was present and recorded. The majority of incidents related to patient identification and selecting the incorrect patient from the medical record. In all instances the error was corrected without further incident. The study also reported that "the presence of scribes at times worked as a protective factor in reducing medical error." The rate of incidents reported where a scribe was present was one in every 300 encounters.

Analysis of notes taken during the above RCT[33] found that the Physician Documentation Quality Instrument[50] used to evaluate the quality of notes did not demonstrate reliability or validity. Authors also described difficulty is assessing note quality for accuracy considering evaluators weren't in the room when the consultation took place. Additional information indicated that notes were longer in the scribe group (357 words) compared to the non-scribe group (237 words; P<.0001) but that there was no difference in their rate of omissions (42% vs 43%) or sufficiency of information to manage the patient (92% vs 93%).

Heaton et al Group (Mayo, Rochester, MN)

Six studies, conducted by the Heaton group, were included that assessed outcomes of interest in emergency department clinics. Because they were all conducted at the same medical center and authored by the same group their findings are likely to be highly correlated across reports within this group (though not considered duplicate results reporting). All studies were prospective cohort studies conducted in the United States. Five studies were rated as serious risk of bias[36,37,39-41] and 1 as moderate.[38] The studies recruited and trained scribes using an in-house training program that was developed by a physician with prior experience with scribes. Detailed ROB ratings can be found in Appendix 4.

Two of the studies reported grant[39] or hospital funding.[41] The studies varied by study period as well as the primary objectives. Scribes were recruited and trained through an in-house training program with a defined curriculum developed by a physician with prior experience implementing scribe programs. Individuals who agreed to participate in the studies included attending physicians,[36-41] residents,[37,38] senior resident physicians,[36-38,41] nurse practitioners,[36-38] physician assistants,[36-38] and interns.[41]

In all studies scribe duties included medical documentation services and clerical support. Most scribes were college students or recent graduates with an interest in health science careers. A summary of reported outcomes is presented in Table 7. Detailed study characteristics can be found in Appendix Table 6-7 and detailed results clinic efficiency and health care system

outcomes can be found in Appendix Table 6-8 and Appendix Table 6-9, respectively. Certainty of evidence tables can be found in Appendix 7.

Table 7. Summary results for emergency department studies (Heaton group, MN)*

Author, Year Risk of Bias Study Characteristics (sample size)	Outcomes									
	Patients per hour per clinician	Door-to-Room/ Waiting Time (minutes)	Door-to-Provider (minutes)	Appointment Length/ Time-to-disposition	Door-to-Discharge/ LOS (minutes)	LWBS	Patient Satisfaction	Clinician Satisfaction	Financial Productivity	Relative Value Units (RVU)
Heaton 2016[36] Serious Prospective Cohort N=8015 patients	↔	NR	↔	↔	↑ 265 vs 255	NR	NR	NR	NR	NR
Heaton 2017a[37] Serious Prospective Cohort N=6119 patients	NR	NR	↔	↔	↔	NR	NR	NR	NR	NR
Heaton 2017b[38] Moderate Prospective Cohort N=39926 visits	NR	NR	NR	NR	NR	NR	NR	NR	NR	↑[a] 4.04 vs 3.84
Heaton 2018[39] Serious Prospective Cohort N=48 shifts	NR	NR	NR	↔	NR	NR	NR	NR	NR	NR
Heaton 2019a[41] Serious Prospective Cohort N=4629 patients	NR	NR	↔	↔	↔	NR	NR	NR	↔[a]	NR
Heaton 2019b[40] Serious Prospective Cohort N=8 shifts	NR	NR	NR	NR	NR	NR	NR	NR	NR	↑[b] $488 vs $600

↔=no significant difference; ↑=increase in outcome compared to control group; ↓=decrease in outcome compared to control group; LOS=length of stay; LWBS=left without being seen; NR=not reported

*Numerical data only presented when deemed statistically significant

[a] mean RVUs per patient
[b] estimated costs of charting per shift

Clinic Efficiency

Patients seen per day

One report from this group, rated as serious risk of bias, reported outcomes related to patients seen per day.[36] The study reported no difference in patients seen per hour among attending physicians with a scribe compared with no scribe; however, no data was provided.

Door-to-provider time

Three reports from this group reported outcomes related to door-to-provider time in the emergency department.[36,37,41] All studies were rated as serious risk of bias.

All studies found median door-to-provider time to be similar in scribe and non-scribe groups, with time ranging from 20 to 25 minutes in the scribe group and 19 to 27 minutes in the non-scribe group. Heaton 2017a[37] and Heaton 2016[36] also found similar times between groups among attending physicians, second- and third-year residents, nurse practitioners, and physician assistants. Additionally, Heaton 2019[41] also compared door-to-provider times in morning, afternoon, and overnight shifts. The study found door-to-provider time to be shorter in the scribe group (21 minutes) compared to the non-scribe group (28 minutes) during overnights shifts (P=.01) but similar during morning and afternoon shifts.

Appointment length

Four reports from this group reported outcomes related to appointment length.[36,37,39,41] All studies were rated as serious risk of bias. Three studies found time in treatment room to be similar in scribe and non-scribe groups, with time ranging from 176 to 222 minutes in the scribe group and 181 to 221 in the non-scribe group.[36,37,41] Heaton 2017[37] and Heaton 2016[36] also found similar times between groups in attendings, second- and third-year residents, nurse practitioners, and physician assistants, while Heaton 2019b[41] found similar treatment room times in morning, afternoon, and overnight shifts.

Heaton 2018[39] reported time spent at patient bedside. Based on 24 shifts, the average time was found to be similar between scribe and non-scribe groups (138 versus 140 minutes, P=.88).

Time to disposition

Three reports from this group, rated as serious risk of bias, reported outcomes related to disposition time.[36,37,41] None found a difference between scribe and non-scribe groups. Two studies reported that the median provider-to-disposition time among patients were similar between scribe and non-scribe groups (P=.51 and P=.32).[37,41] The third study also found median provider-to-disposition times among providers were similar between groups (P=.15).[36]

Length of stay/Door-to-discharge time

Three studies, rated as serious risk of bias, reported outcomes related to length of stay.[36,37,41] Outcomes were mixed. Two studies reported median length of stay among patients and found it to be similar between scribe and non-scribe groups, 215 versus 214 minutes (P=.34) and 267 versus 272 minutes (P=.34).[37,41] In comparison, the third study found median length of stay among clinician s to be greater in the scribe group, 265 versus 255 minutes (P=.03).[36]

Patients left without being seen

The Heaton group did not report on outcomes related to the number of patients who left without being seen.

Patient/Clinician Satisfaction

None of the Heaton group's eligible articles reported patient or clinician satisfaction regarding the use of medical scribes in the emergency department.

Health Care and System Outcomes

Financial productivity and relative value units

Three studies reported outcomes related to cost or revenue. One study was rated as moderate risk of bias[38] and the other 2 as serious risk of bias.[40,41] Results were mixed.

Heaton 2017[38] estimated the mean RVUs per patient to be higher in the scribe group compared to the non-scribe group (4.04 vs 3.84 per patient [mean difference [MD] 0.20, P<.001]). In post hoc analyses they also found RVUs to be higher in the scribe group among patients with emergency severity levels of 2 and 3 (P<.001) but similar among severity levels of 1, 4, and 5 (P value ranges from .10 to 0.63). RVUs were also higher in chest pain, heart, and respiratory emergencies (P<.001); ear, throat, and nose emergencies (P=.04); leg fractures (P=0.027); and psychiatric emergencies (P=.002). In comparison, patients in the scribe group had lower RVUs in vision emergencies (P=.027).

Heaton 2019[41] estimated the mean RVUs were similar between scribe and non-scribe groups, 4.79 versus 4.72 (P=.76).

One study reported the cost of charting per shift.[40] The cost of a physician per clinical hour was estimated to be $200 and the cost of a scribe was $11. For every 3 hours, the study estimated costs to be $488 in the scribe group (accounting for 2 hours of clinical work and 1 hour of scribe work) compared to $600 in the non-scribe group.

Other health care and systems outcomes

The Heaton group did not report any outcomes related to time to train scribes, turnover of scribes, medical errors, or quality of documentation.

Other Publications (United States and Canada)

Eight additional studies were included that assessed outcomes of interest in emergency department clinics.[42-49] Seven studies were pre-post design and 1 was a randomized controlled trial.[45] One study instituted an in-house 60-hour training program and required 2 years of clerical experience.[43] Six additional studies used outside vendors to employ and train scribes, One company considered scribes to be proficient after 15 shifts and skilled after 45 shifts[47] while another company considered scribes to be proficient after 20 shifts and skilled after 40 shifts.[49] Six of the 7 pre-post studies were rated as serious risk of bias and 1 was rated as moderate risk of bias.[43] The single randomized controlled trial was rated as moderate risk of bias.

Seven studies were conducted in the United States[42-45,47-49] and 1 in Canada.[46] Of the 2 studies that reported funding, 1 was funded by hospital and foundation,[46] the other by foundation and industry.[45]

Six studies employed scribes using independent scribe companies responsible for hiring and training.[44-49] One trial instituted a 60-hour training program and required scribes to have 2 years of experience.[43] One study considered scribes skilled after 45 shifts[47] and another after 40 shifts.[49]

In all studies scribe duties included medical documentation services and clerical support. Most scribes were college students or recent graduates with an interest in health science careers. The number of clinicians included in the studies ranged from 26 to 103, and scribe to doctor ratio was typically 1 to 1.

Detailed ROB assessments can be found in Appendix 4. A summary of reported outcomes is presented in Table 8. Detailed study characteristics can be found in Appendix Table 6-10 and detailed results for clinic efficiency, patient and clinician satisfaction, and health care system outcomes can be found in Appendix Table 6-11, Appendix Table 6-12 and Appendix Table 6-13, respectively. Certainty of evidence tables can be found in Appendix 7.

Table 8. Summary results for emergency department studies (US and Canada)*

Author, Year Risk of Bias	Outcomes									
	Patients per hour per clinician	**Door-to-Room/ Waiting Time (minutes)**	**Door-to-Provider (minutes)**	**Appointment Length/ Time-to-disposition**	**Door-to-Discharge/ LOS (minutes)**	**LWBS**	**Patient Satisfaction**	**Clinician Satisfaction**	**Financial Productivity**	**Relative Value Units**
Allen, 2014[42] Serious Retrospective Cohort (pre-post) N=NR	↔	↔	↔	↓ 157 vs 169	↓ 233 vs 249	↔	NR	+	NR	NR
Arya, 2010[43] Moderate Retrospective Cohort (pre-post) N=243 shifts	↑ +1.63[a]	NR	NR	NR	↔	NR	NR	NR		↑[a] +0.24
Bastani, 2013[44] Serious Prospective Cohort (pre-post) N=24,338 patients	NR	↓ 34 vs 35	↓ 61 vs 74	↓ 185 vs 237	↓ 269 vs 289	NR	↑[b] 58% vs 75%	↑[c] 62% vs 92%	NR	NR
Friedson, 2018[45] Moderate RCT N=905 shifts	↑ 2.33 vs 2.23	NR	NR	↓ 228 vs 258	NR	NR	NR	NR	NR	↔[d] ↑[e] 72 vs 77
Graves, 2018[46] Serious Prospective Cohort (pre-post) N=158 shifts	↑ 2.81 vs 2.49	NR	NR	NR	NR	NR	NR	NR	NR	NR
Hess, 2015[47] Serious Prospective Cohort (pre-post) N=103 providers	↔	NR	NR	NR	↔	↑	NR	+[f]	NR	↔/↑[g]

Ou, 2017[48] Serious Qualitative survey N=47 residents	NR	NR	NR	NR	NR	NR	NR	+[h]	NR	NR
Shuaib, 2017[49] Serious Prospective Cohort (pre-post) N=23,319 encounters	↑ 3.2 vs 2.3	↓ 41 vs 37	↓ 56 vs 61	↓ 228 vs 237	↓ 287 vs 303	NR	↔	↑[i] 66% vs 81%	NR	↔[j] ↑[k] 241 vs 336

↔=no significant difference; ↑=increase in outcome compared to control group; ↓=decrease in outcome compared to control group; +=satisfaction reported, but no comparison group; LOS=length of stay; LWBS=left without being seen; NR=not reported; RCT=randomized controlled trial

*Numerical data only presented when deemed statistically significant

[a] RVUs per hour increased by 0.24 units for every 10% increment in scribe usage during a shift
[b] Press Ganey Survey: Overall patient satisfaction percentiles
[c] Press Ganey Survey: Overall physician satisfaction percentiles
[d] total RVUs per shift
[e] trimmed RVUs per shift (lowest and highest 10% removed from analysis)
[f] 62% clinicians "liked or loved working with scribes", 74% clinicians "positive or very positive attitude towards scribes", 82% clinicians "positive or very positive changes in efficiency"
[g] Pre-post differences in seasonally-matched productivity metrics; mean differences in RVU per patient and RVU per hour were mixed
[h] 85% residents "my interactions with attendings have improved with scribes", 79% "scribes have improved my overall education as a resident in the emergency department"
[i] "Physician satisfaction increased 15% from pre- to post-scribe" (p=NR)
[j] mean RVUs per patient
[k] mean total RVUs per hour

Clinic Efficiency

Patients seen per day/hour/shift

Six studies reported outcomes related to patients seen per day, per hour or per shift. Five studies were pre-post[42,43,46,47,49] and 1 was a randomized controlled trial.[45] Four of the studies were rated as serious risk of bias, and 2 were rated as moderate.[43,45] Results generally suggested that scribes were associated with an increase in the number of patients seen per day, per hour or per shift.

One RCT[45] found that the number of patients per shift increased with scribes compared to non-scribed shifts, 18.6 per clinician per shift versus 17.8 (MD=0.8, P<.05). Four pre-post studies also found an increase in patients seen per provider shift or per day[43,46,47,49] One study found no difference in the number of registered visits seen with and without a scribe (MD=-0.99, P=.47).[42]

Additionally, 1 study conducted a post-only survey in which 77% of residents stated that scribes allow them to see more patients.[48]

Door-to-room time/waiting time

Three pre-post studies reported on outcomes related to emergency department waiting time. Results were mixed. All studies were rated as serious risk of bias.[42,44,49] One study found door-to-room waiting time to be less in scribed cohorts compared to non-scribed cohorts, 37 versus 41 minutes (P<.0001).[49] A second study found door-to-room waiting time to be similar between scribe and non-scribe cohorts in the total cohort (MD=-0.01; P=.65). However, the study found door-to-room waiting time to be lower with scribes among admitted patients (MD=0.02; P=.001).[42] A third study also found waiting time to be similar between groups, 34 versus 35 minutes.[44]

Two studies reported room-to-provider times.[44,49] One study found room-to-provider time to be less in the scribe cohort compared to the non-scribe cohort, 24 versus 26 minutes (P<.0001).[49] The second reported room-to-provider waiting time to 31 minutes in the scribe group and 39 minutes in the non-scribe group.[44]

Additionally, 1 study reported door-to-triage waiting time and found it to be less with a scribe (MD=-0.01; P=.008).[42] Door-to-triage waiting time was also found to be less with a scribe among admitted patients (MD=0.02; P<.001) but not among discharged patients (MD=0; P=.20).

Door-to-provider time

Three pre-post studies, rated as serious risk of bias, reported mean door-to-provider time in the emergency department.[42,44,49] Door-to-provider time is defined as the time elapsed from when the patient arrives in the ED until the physician signs on to the patient's chart. Results were mixed.

Two studies found door-to-provider time to be significantly lower in the scribe group compared to the non-scribe group. Bastani et al[44] reported door-to-provider time to be 61 minutes with a scribe versus 74 minutes without a scribe (P<.0001). Shuaib et al[49] reported 56 minutes with a scribe versus 61 minutes without a scribe (P<.0001).

However, the third study did not find a significant difference between the scribe and non-scribe groups, reporting 1.28 mean hours (76.8 minutes) with a scribe versus 1.34 (80.4 minutes) mean hours without a scribe (P=.07).[42]

Appointment length/Time-to-disposition

Four studies reported mean provider-to-disposition time, defined as the time elapsed from when the physician signs on to the patient's chart to the time the patient is discharged or admitted.[42,44,45,49] All 4 studies reported lower mean provider-to-disposition time in the scribe group compared to the non-scribe group. Three of these studies were pre-post prospective cohort studies and rated as serious ROB.

The first study reported provider-to-disposition time to be shorter with a scribe compared to without a scribe, 228 versus 237 minutes (P<.0001).[49] The second study also found provider-to-disposition time to be shorter in the scribe cohort, 2.61 versus 2.82 minutes (MD=-0.21; P<.001). This difference was found in both admitted (MD=-0.38; P<.0001) and discharged patients (MD-0.09; P=.021).[42] The third study reported the average provider-to-disposition time to be 185 minutes in the scribe cohort and 237 minutes in the non-scribe cohort (P<.0001).[44] The fourth study was a randomized controlled trial, rated as moderate risk of bias.[45] The trial found provider-to-disposition time was shorter in the scribe group compared to the non-scribe group, 3.8 mean hours (228 minutes) versus 4.3 (258 minutes) (P<.01).

Shuaib et al[49] conducted a time-motion analysis of provider activities, breaking down different parts of a patient visit. Chart prep, chart review, and post-visit documentation were all found to be significantly lower in the post-scribe group (P<.01), while physical examination time was similar between groups. The study found doctor-patient interaction time to be greater in the scribe cohort compared to the non-scribe cohort, 7.8 mean minutes versus 4.0 (P<.01).

Length of stay/Door-to-discharge time

Five pre-post studies reported outcomes related to time spent in the emergency department and length of stay. Four studies were rated serious ROB[42,44,47,49] and 1 was rated moderate.[43] Results were mixed.

One study defined "length of stay" as the time between arrival of the patient and departure from ED.[47] Two other studies used the term "length of stay", but did not define it further.[44,49] One study referred to this as "turn-around-time", defined as the difference between electronically generated arrival and discharge times.[43] Of these 4 studies, 2 reported length of stay to be significantly lower in the post-scribe group, while the other 2 reported the pre-and-post mean length of stay to be similar between groups. Shuaib et al[49] found the length of stay, on average, to be shorter in the scribe cohort among both admitted patients, 473 minutes versus 507 minutes (P<.0001) and discharged patients, 287 minutes versus 303 (P<.0001). Bastani et al[44] also reported length of stay, on average, to be shorter in the post-scribe cohort in both admitted, 442 minutes versus 448 (P<.0001), and discharged patients, 269 minutes versus 289 (P<.0001). Comparatively, the Hess et al[47] found length of stay to be similar between scribe and non-scribe cohorts (MD=0.14 [95% CI -0.05, 0.33; P=.15]). Arya et al[43] reported turn-around-times (in minutes) were not significantly affected by scribe usage, when scribes were utilized in 10% increments during a shift (0.4 [95% CI -5.3, 6.1; P=.88]). The fifth study reported average door-to-exit time, defined as the time elapsed from when a patient arrives in the ED to the time the

patient exits the ED, was greater in the pre-scribe cohort compared to the post-scribe cohort, 5.76 hours (345.6 minutes) versus 5.62 (337.2 minutes) (P=.021).[42] The study found the average door-to-exit time to be greater among admitted patients in the post-scribe group, 8.27 mean hours(496.2 minutes) versus 7.61 (456.6 minutes; MD=0.65, P<.0001); however the time was shorter among discharged patients (4.89 hours/293.4 minutes versus 5.07 hours/304.2 minutes; MD=-0.18; P=.01). This study also reported door-to-disposition time, defined as the time elapsed from when the patient arrived in the ED until the clinician decided a patient's disposition. Allen et al reported, on average, a shorter door-to-disposition time with scribes compared to without scribes, 3.89 (233.4 minutes) versus 4.16 (249.6 minutes) hours (MD=-0.27; P<.0001). The difference was also found among discharged (MD=-0.16; P=.03) and admitted (MD=-0.38; P<.0001) patients.

Patients left without being seen

Two pre-post studies reported on the number of patients that left without being seen. Both studies were rated as serious risk of bias.[42,47] Results were mixed.

Hess 2015 reported a greater number of patients left without being seen in the scribe cohort compared to non-scribe cohort, 4.41 versus 2.94 (1.47 [95% CI 0.83, 2.11; P<.01]), while Allen 2014 found no difference in scribe and non-scribe cohorts, 5% versus 5% (P=.38).

Patient Satisfaction

Two pre-post studies, rated as serious risk of bias, reported patient satisfaction with mixed results. Using a Likert scale (1=poor to 5=excellent), Shuaib et al[49] asked 6 questions: 1) the doctor carefully listened to concerns; 2) the doctor explained things in a way you can understand; 3) meticulousness of examination; 4) doctors instructions concerning follow-up care; 5) the doctor was courteous; and 6) the doctor provided satisfactory feedback to questions. Results were similar for questions 1-5 for the pre-and-post scribe groups. However, the sixth question had higher scores in the post-scribe group compared to the pre-scribe group, 4.7 versus 3.9 (P<.01).[49]

Using the Press Ganey Survey, the second pre-post study found 'patient satisfaction' increased from the 58th percentile in the pre-scribe group to the 75th percentile in the post-scribe group.[44]

Clinician Satisfaction

Five studies reported on clinician satisfaction. All studies were rated as serious risk of bias. Two studies conducted surveys pre-and-post scribes,[44,49] 1 conducted pre-and-post surveys with additional post-only questions[48] and 2 conducted post-only surveys to measure clinician satisfaction.[42,47] Of the 3 that conducted pre-and-post surveys, 1 reported an increase in clinician satisfaction using the Press Ganey Survey from the 62nd percentile to the 92nd percentile in the pre-and-post scribe groups, respectively.[44] Another reported that physician satisfaction increased from 66% to 81% in the pre-and-post scribe groups, respectively, but did not provide further information about how it was measured.[49] The third study was a survey study measuring resident perceptions of their educational experience before and after a scribe program implementation.[48] Ou et al[48] conducted a pre-and-post survey, and additional questions post survey. Only 1 question from the pre-and-post survey was significantly different between groups, "I have enough fact-to-face teaching with the attendings during my shift". Of the 47 residents surveyed,

17% agreed to this statement during the pre-scribe survey and 55% agreed during the post-scribe survey (p<.001). Among the 47 resident clinicians, 85% reported "my interaction with attendings have improved with the implementation of scribes" and 79% reported "scribes have improved my overall education as a resident in the emergency department" in the post-only survey.

Among the 2 studies that provided post-only data, both reported clinicians were satisfied with the implementation of a scribe program. Hess et al[47] reported that among 71 providers, 62% "liked or loved working with scribes"; 74% had an "overall positive or very positive attitude toward scribes"; and 82% experienced "positive or very positive changes in efficiency". Allen et al[42] reported that among 20 providers, 100% agreed with the statement, "scribes are a valuable addition", 67% agreed with "scribes increase workplace satisfaction", and 89% agreed with "scribes increase quality of life".

Health Care and System Outcomes

Financial productivity and relative value units

One randomized controlled trial[45] and 4 pre-post studies[43,46,47,49] reported outcomes related to financial impacts. The randomized controlled trial was rated as moderate risk of bias, 3 studies as serious risk, and 1 study as moderate risk.[43] In general, scribes were associated with a positive financial impact, though none of the studies reported on the cost of the contracted services required to hire, train, maintain, and supervise scribes.

The randomized controlled trial reported total RVUs between scribe and non-scribe groups. Total RVUs were similar between scribe and non-scribe groups, 76.5 versus 7.3 (MD=2.14; P=non-significant; no numerical value reported). However, after excluding shifts with the highest and lowest 10% of RVUs from analysis, total RVUs were greater in the scribe group, 76.9 versus 72.0 (MD=4.87; P<.01).[45]

In the first pre-post study, the average costs of a clinician amounted to $1200 per shift ($150 per hour) and the average costs of scribes were estimated to be $216 per shift ($27 per hour). The study assessed that "given 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". The study suggested a greater income with scribes even after accounting for associated scribing costs.[46]

The second study found RVUs per patient to be similar between scribe and non-scribe groups, 2.74 versus 2.57 (P=.88). However, the study found RVUs per hour to be greater in the scribe group compared to the non-scribe group, 336 versus 241 (P<.001).[49]

The third study compared a 4-month period (September-December 2011) before scribe implementation to the same 4-month period (September-December 2012) after the scribe implementation. The study found mean RVUs per hour to be greater in the scribe group, though small in magnitude in September (MD=0.00008; P=.03), October (MD=0.00016; P<.01), and November (MD=0.0001; P=.03), but similar in December (MD=0.00003,P=.57). Mean RVUs per patient were also assessed between scribe and non-scribe groups. RVUs per patient were greater in the scribe group in October (MD=0.00007; P<.01) but similar in September (MD=0.00001; P=.39), November (MD=0.0; P=.98), and December (MD=-0.00003; P=.08).[47]

The fourth pre-post study reported an additional 24 RVUs per 10-hour shift with the use of scribes (P=.00011).[43]

KEY QUESTION 2: HOW DO THE EFFECTS OF MEDICAL SCRIBES VARY BASED ON DIFFERENCES IN COMPENSATION STRUCTURE, QUALIFICATIONS, TYPES OF ENTRIES, OR SETTING?

Summary of Findings

Key Messages

- No eligible studies were identified that reported if the effects of medical scribes varied based on differences in compensation structure, qualifications, types of entries, or other scribe-permitted tasks or scribe-specific qualifications, or setting within orthopedic or cardiology clinics.

- No eligible studies were identified that reported if the effects of medical scribes varied based on differences in compensation structure, types of entries, or other scribe-permitted tasks or scribe specific qualifications within emergency departments.

- Evidence was insufficient to determine whether the effect of medical scribes on emergency department efficiency varied based on clinician training, experience, or area of service within the emergency department.

Very few articles were identified (k=5) that addressed how the effects of medical scribes vary based on provider qualifications and setting. Additionally, no studies compared scribes employed and contracted by outside vendors to those trained and employed by medical institutions. Summary characteristics of the scribe training programs for each eligible study can be found in Table 9. All studies required additional on-the-job training regardless of the hiring mechanism.

Table 9. Summary characteristics of scribe training programs

Author, Year	Risk of Bias	Location	Training Supplied by:		Total Training	Experience	Training Characteristics			
			In-house	Vendor			Classroom lecture	On-line/ training manual	On-floor training	Supervised scribing
Orthopedics										
No eligible studies identified										
Cardiology										
Bank, 2015[29]	Serious	United States		X	184 hours	6 years	X		X	X
Emergency Department										
Walker, 2016a[31]	Serious	Australia		X	NR	2 years	NR			
Walker, 2016b[32]	Serious		X		68-118	None		X	X	X
Walker, 2017[33]	Moderate									
Dunlop 2018[34]	Serious									
Walker, 2019*[35]	Moderate									
Heaton, 2016[36]	Serious	United States	X		NR	NR		X	X	X
Heaton, 2017a[37]	Serious									
Heaton, 2017b[38]	Moderate									
Heaton, 2018[39]	Serious									
Heaton, 2019a[40]	Serious									
Heaton, 2019b[41]	Serious									
Allen, 2014[42]	Serious	United States	NR		NR	NR	NR			
Arya, 2010[43]	Moderate	United States	X		60 hours	NR				X
Bastani, 2014[44]	Serious	United States		X	NR	NR	NR			
Friedson, 2018*[45]	Moderate	United States		X	NR	NR	NR			
Graves, 2018[46]	Serious	Canada		X	NR	NR			X	X
Hess, 2015[47]	Serious	United States		X	NR	NR			X	X
Ou, 2017[48]	Serious	United States		X	6-8 weeks	NR	X		X	X
Shuaib, 2017[49]	Serious	United States		X	NR	NR			X	X

NR=not reported

Emergency Department: Walker et al Group (Victoria, Australia)

Clinic Efficiency

Patients seen per hour

Walker 2016a[31] assessed the number of patients seen per hour for 5 individual doctors with and without a scribe. A 9-15% relative increase was reported, varying by doctor, but did not provide any further detail about specific physicians' qualifications or experience that may account for these varying effects. The article concluded it would be more cost-effective to allocate scribes to faster doctors.

Walker et al (2019)[35] assessed the number of patients seen per hour per doctor by different regions of the emergency department. No significant differences were found during sub-acute, fast-track, or observation ward shifts. A small but statistically significant increase was reported for "acute" shifts, (increase of 0.09 (0.03 to 0.15) patients per hour per doctor), and larger increase for "senior doctor at triage" shifts, (increase of 0.53 (0.14 to 0.93) patients per hour per doctor).

Emergency Department: Heaton et al Group (Mayo, Rochester, MN)

Clinic Efficiency

Provider-to-disposition

Heaton 2016[36] assessed provider-to-disposition time by training experience and found no difference between scribe and non-scribe groups among attending physicians, year-2 residents, year-3 residents, and nurse practitioners or physician assistants. Heaton 2017 also assessed provider to disposition time by clinic area and found no difference between scribe and non-scribe groups in areas seen by attending physicians with residents (P=.21) or attending physicians with nurse practitioners or physician assistants (P=.42).

Heaton 2019[41] also assessed provider-to-disposition time among patients by time of shift. They study found median disposition times were similar between groups in morning (189 minutes in non-scribe group vs 179) and afternoon (223 minutes in non-scribe group vs 224) shifts but higher in the scribe group in overnight shifts (146 minutes in non-scribe group vs 156) (P=.01).

Length of stay

Heaton 2016[36] assessed length of stay by training experience and found no difference between scribe and non-scribe groups among attending physicians (P=.06), year-2 residents (P=.55), and nurse practitioners or physician assistants (P=.39). However, length of stay was shorter among patients seen by year-3 residents, 244 versus 262 minutes (P=.02).

Heaton 2017[37] assessed length of stay by clinic area and found no difference between scribe and non-scribe groups in areas seen by attending physicians with residents (P=.18) or attending physicians with nurse practitioners or physicians assistants (P=.80).

Heaton 2019[41] assessed length of stay among patients by time of shift. They study found median disposition times were similar between groups in morning (P=.13), afternoon (P=.86), and overnight (P=.86) shifts.

SUMMARY AND DISCUSSION

Findings from our systematic review on the effects of medical scribes in orthopedic, cardiology, and emergency departments are limited by the quantity, quality, completeness, and applicability of information. Available information is based on studies mostly rated as having serious risk of bias and of limited applicability to widespread implementation. There are no data in VA health care settings or among Veterans. Much of the information from emergency departments is from 2 single-site centers (one from Australia and another from the US). Thus, findings across multiple reports from these groups are likely to be highly correlated even though they are not considered duplicate outcomes reporting. Studies typically recruited interested clinician participants and began data collection following scribe and clinician training run-in periods. Studies did not report all outcomes of interest and rarely provided adequate information on resources required to hire, train, maintain, and supervise scribes.

No data were identified on medical scribes in orthopedic clinics. In cardiology clinics the efficiency and financial productivity of scribe programs is uncertain, with findings based on a single, serious risk of bias study from a cardiology group in Minneapolis, MN that evaluated medical scribes provided by a vendor. No data are available on the effect of medical scribes on patient and provider satisfaction in cardiology clinics.

Most of our findings are from studies conducted in emergency departments, much of them limited to 2 groups publishing multiple results of various measures of scribe related outcomes. In emergency departments, medical scribes may improve efficiency (low certainty of evidence [COE]) and financial productivity (low COE). The magnitude of effect on efficiency is likely small to moderate. Efficiency varies based on the setting, outcomes assessed, and methods for evaluating financial productivity. The effect on costs is difficult to ascertain as complete cost reporting was not provided. Resources to identify, hire, train, staff, maintain, and monitor a scribe program are expected to be substantial, rarely reported in the literature, and not readily available through online searches. Thus, net financial impact is not known and likely varies by key assumptions and methods for scribe program development, implementation, and maintenance. All the studies that reported on financial productivity reported estimations based on a typical scribe salary and average billings, and none of the identified studies were true economic evaluations incorporating all costs attributed to the scribe intervention, including administrative or supervisory cost; the cost of identifying, hiring, training, supervising, maintaining, or replacing scribes; documentation verification costs; or costs related to contracting through outside vendors. Medical scribes may make little to no difference in door-to-room or door-to-provider time, number of patients who left without being seen, and patient or clinician satisfaction, though results were mixed. There are no direct comparative data on quality of documentation, medical errors, or scribe training (*eg,* time to train, turnover), and no data comparing these outcomes in contracted (*ie*, vendor supplied) scribes versus scribes trained in-house or using virtual scribes.

We identified only 1 study that provided a detailed analysis of the implementation of a scribe training program, which was implemented in Australia. Few US studies provided any details about scribe training, and no studies described the time it takes to orient a contracted scribe to the health care facility in which they are working.

The data identified from the emergency departments are not necessarily generalizable to other clinics, as these departments function differently, have variation in measured metrics (*ie*, panel size vs number of patients seen per day) and have a different financial model. Outcomes of interest to emergency departments are not necessarily the same as other specialty clinics. For example, an emergency department may be able to alter staffing schedules if 1 doctor can see more patients in a shift, where the only way to alter the number of patients seen in a shift in the cardiology clinic is to alter the clinicians schedule. The single cardiology study we identified reported that the clinicians with scribes allocated to them had altered schedules which allowed them to see more patients per day. No emergency department studies discussed altering staffing ratios.

Though we did not identify any studies assessing virtual scribes, many vendors offer the service. Virtual scribes may be of increasing interest as they may allow for increased accessibility, especially in rural areas or in cases of a pandemic, as well as potentially save money as they can be used on-demand.[51]

Additional information on the role of medical scribes in primary care and other specialty settings was beyond the scope of our report and not included. However, these studies are typically of similar methodological quality to those identified in our report – that is, single-site reports with clinician volunteers, vendor supplied scribes, and limited outcome (including financial) reporting. Their results suggest modest effects for improving documentation time and patient satisfaction.[15] It is not known how the results from these settings can be applied to future implementation in orthopedic, cardiology, and emergency departments. A prior systematic review identified 5 studies published through 2014 and noted limited quality and quantity of information.[16]

LIMITATIONS

This review had several limitations. Evidence evaluating the effect of medical scribes was very limited and of poor methodological quality. Only 2 RCTs were identified, 1 conducted in Australia. Also, the bulk of the available evidence comes from 2 distinct groups, using the same general population in several studies and from single-site settings. There also was no reliable evidence available to address different aspects of a scribe program, such as quality of documentation and medical errors. Data on financial impacts was difficult to interpret, as most studies did not report the cost of initiation, implementation, or sustainability. Studies that used vendor services did not include the cost of these vendor services in their estimates of revenues. Variation in training programs and requirements put forth by scribe vendors was not well described. Measures used to quantify outcomes also varied widely across studies. There were also no data on the organizational structures and resources needed to develop and maintain scribe programs as well as barriers and facilitators to implementation.

Applicability of Findings to the VA Population

Current findings have limited applicability and raise important questions about implementation, research gaps and future research. Despite information that there may be 100,000 medical scribes in the US in 2020,[17] there is a paucity of data on the effectiveness, harms, costs, and quality of scribes, or on best methods for implementation and evaluation. No studies were conducted in Veterans Affairs Medical Centers and the effectiveness and financial productivity for widespread

implementation across a national health care system are not known. Several reports were not from the US, and many evaluated programs after training had been completed and limited inclusion to clinicians volunteering for scribe services. Additionally, a large amount of information was reported from 2 emergency department groups, 1 in Australia. The only report from a cardiology department was limited to a single clinic in the US that assigned scribes to clinician volunteers and altered the daily schedule of clinicians working with scribes to permit more clinic visits. Scribes in the cardiology report were hired by an outside vendor and had extensive experience. Charges and costs for the services provided by the vendor were not described. None of the programs described the possible role of allocating scribe services to employees currently assigned other clinic duties, including administrative, nursing or "clinician extenders". The effect of scribes on improving efficiency, patient access, and throughput likely also requires additional programmatic factors including reducing clinic appointment times and increasing the number of patients scheduled per day.

RESEARCH GAPS/FUTURE RESEARCH

Our principal finding is that there are large gaps in evidence that require future research. Despite the marked increase in the use of medical scribes in the United States, there is no high-quality information evaluating their effects on clinic efficiency, health care access, patient or clinician satisfaction, or financial investment and productivity in cardiology, orthopedic and emergency departments. There are no data on the use of virtual scribes. Additionally, there are limited data on other important aspects of a medical scribe program, including documentation quality, the comparative effects of in-house versus contracted hiring, training, maintaining, and/or supervising, large-scale implementation of medical scribes, and other components to medical scribe programs required to enhance care quality, including productivity. Future research should be more transparent about costs related to contracting scribes through a vendor, as well as any administrative oversight costs that must exist even when using a vendor for scribes. Data from other clinical settings (primary care and other specialty clinics) is of limited applicability, quality, and quantity.

POLICY IMPLICATIONS

Our results have policy implications and suggest that prior to widespread implementation, more information is needed on the effectiveness, harms, and costs of scribe programs. If information is deemed sufficient for programmatic rollout, then clear identification and evaluation of programmatic goals (improving access and patient/provider satisfaction, enhancing documentation quality, increasing clinical throughput), resources, programmatic models, and personnel required, as well as implementation barriers and facilitators, are needed.

CONCLUSIONS

Based on mostly serious risk of bias reports, in-person medical scribes may improve clinic efficiency and improve financial productivity and revenue as measured by relative value units in emergency departments. The effects on clinic efficiency appear to be small in magnitude and dependent on the type and method of outcome assessment. Cost and financial productivity data do not include the cost of hiring, training, maintaining, and supervising scribes. Generalizability of findings outside the reported settings is limited. The effect of medical scribes in cardiology departments is uncertain. There is no information from orthopedic departments or VA Medical

Centers, or on virtual scribes. There is little information on patient or clinician satisfaction, scribe documentation quality, or whether results vary by in-house versus contracted hiring and training.

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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	<u>Primary:</u> 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	<u>Secondary:</u> 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 Study design	Patients Seen Per Day		Door-to-Provider		Door-to-Discharge/Length of Stay	
	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* **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 Study design	Patient Satisfaction		Provider Satisfaction	
	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] ***RVUs per patient*** *September 2011:* 0.0007 % change=1.84 Mean difference=0.00001 95% CI [-0.00001, - 0.00003; P=.39] *October 2011:* 0.0009 % change=7.83 Mean difference=0.00007 95% CI [-0.00003, - 0.00001; P<.01] *November 2011:* 0.0007 % change=-0.33 Mean difference=0 95% CI [-0.00002, - 0.00002; P=.98] *December 2011:* 0.0009 % change=-3.45 Mean difference=-0.00003 95% CI [-0.00003, - 0.00006; P=.08]	*December 2012:* 0.0017 ***RVUs per patient*** *September 2012:* 0.0007 *October 2012:* 0.0008 *November 2012:* 0.0007 *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)	N=1,042 shifts N=49,445 patients N=23,319 encounters N=103 clinicians	Serious	Direct	Imprecise	Inconsistent	Undetected	Very Low[a,b,c]
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)							
Heaton, 2017a[37] Pre-post ROB: Moderate	No difference with scribes versus no scribes							
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 N=26319 encounters						
Graves, 2018[46] ROB: Serious	Increase in patients per hour with scribes (2.81 vs 2.49)							
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