Use of telehealth in the management of non-critical emergencies in rural or remote emergency departments; a systematic review.

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Abstract

Background

Telehealth has been used extensively in Emergency Departments to improve healthcare provision. However, its impact on the management of non-critical emergency presentations within rural and remote ED settings has not been adequately explored. The objective of this systematic review is to identify how telehealth has been used to assist in the management of non-critical presentations in rural and remote emergency departments and the outcomes.

Methods

Articles were identified through database searches of CINAHL, Cochrane, MEDLINE (OVID), Informit and SCOPUS, as well as screening of relevant article reference and citation lists. To determine how telehealth can assist in the management of non-critical emergencies, information was extracted relating to telehealth program model, the scope of service and participating health professionals. The outcomes of telehealth programs were determined by analysing the uptake and usage of telehealth, the impact on altering diagnosis or management plan as well as patient disposition including patient transfer, discharge, local hospital admission and rates of discharge against medical advice.

Results

Of the 2532 identified records, fifteen were found to match the eligibility criteria and were included in the review. Uptake and usage increased for telehealth programs predominantly utilised by nursing staff with limited local medical support. Tele-consultation conservatively altered patient diagnosis or management in 18-66% of consultations. Although teleconsultation was associated with increased patient transfer rates, unnecessary transfers were reduced. Simultaneously, an increase in local hospital admission was noted and less

patients were discharged home. Discharge against medical advice rates were low at 0.9-1.1%.

Conclusion

The most widely implemented hub-and-spoke telehealth model could be incorporated into existing referral frameworks. Telehealth programs may assist in reducing unnecessary patient transfer and secondary overtriage, while increasing the capacity of ED staff to diagnose and manage patients locally, which may translate into increased local hospital admission and reduced discharge rates following teleconsultation.

Introduction

Higher mortality rates have been reported for patients presenting to rural or remote emergency departments (EDs), compared to similar presentations within urban settings.[1, 2] Many rural hospitals have difficulties attracting and retaining doctors due to financial limitations and geographic undesirability, complicating the task of providing emergency health care.[3, 4] Small rural towns may only have a single doctor, requiring nurses to manage emergencies without medical cover at times.[4] In comparison, urban EDs are usually well supported with advanced imaging modalities and ease of referral to specialists for further definitive management.[3] In rural EDs, advanced imaging modalities, specialist support and definitive management may not be readily available, consequently patient treatment may be delayed, or suboptimal.[3] Some emergency presentations are especially time sensitive with urgent definitive management and interventions required to minimise adverse outcomes.[1, 2, 5-7]

Rural and remote EDs are generally low acuity with infrequent high acuity presentations.[2, 3, 8] If required, patients can be transferred to the nearest regional, or tertiary hospital which can provide definitive management. However, providing emergency care in rural and remote EDs can be complex. Ideally, patients would be accurately assessed to reduce secondary overtriage and maximise patient management within local hospitals.

Telehealth can significantly improve health care provision in rural and remote EDs through the development of cost effective models which remain similar in quality to physician

staffed services. Using two-way interactive technology and telecommunication through telehealth improves collaboration through telephone or videoconferencing consultations between referring hospitals and receiving hospitals which may reduce secondary overtriage and optimise patient management within community hospitals.[1, 9] Telehealth can significantly improve health care provision in rural and remote EDs through the development of cost effective models which remain similar in quality to physician staffed services.[3, 10] Previous studies have demonstrated that telehealth assisted with patient assessment, resulted in improved patient care, increased the capacity of rural staff to manage patients locally, minimised time away from support networks and reduced unnecessary retrievals.[11, 12] In critical presentations, telehealth has reduced morbidity and mortality rates, hospital admission time and cost of patient care.[1, 2, 13]

Although non-critical presentations are the most frequently encountered presentations, limited articles evaluate the use of telehealth to assist in the management of non-critical emergency presentations within rural and remote EDs. Existing articles exploring the role of telehealth in EDs often expand the setting of interest to include primary care facilities and minor injury treatment centres, or do not specifically focus on non-critical presentations to rural and remote EDs.[5, 14-19] To fill this knowledge gap, a systematic review was conducted to identify how telehealth has been used to manage non-critical emergency presentations in rural and remote EDs. The review aimed to answer the following research questions:

1. How has telehealth been used to manage non-critical emergency presentations?
2. What were the telehealth program outcomes?

For the purpose of this review, non-critical presentations are defined as clinical presentations in which there was no imminent threat to life, or limb, or function. The definition roughly correlates to Australian Triage Scale category 3-5.[20]

Methods

The review protocol was developed using the Preferred Reporting Items for Systematic Reviews and Metal-Analysis for Protocols (PRISMA-P) 2015 and was assigned the registration number CRD42016042649 upon registration with PROSPERO.[21]

Literature search and information sources

The search strategy was designed to maximise the return of relevant articles relating to telehealth and EDs. Given the terms "telehealth" and "telemedicine" are often used interchangeably, both were included in the key words.[13] Other keywords included "tele-consultation", "tele consultation", "videoconference", "mobile health" and "teleradiology". To capture articles relating to EDs, the following key words were included "emergency medicine", "accident and emergency", "emergency department", "emergency services", "emergency units", "patient transfer", "rural" and "remote".

Keywords and MeSH terms were used to search in CINAHL, Cochrane, MEDLINE (OVID), Informit and SCOPUS databases in July 2016. Searches of reference and citation lists were repeated in March 2017, to identify and include relevant new articles.

Eligibility criteria

To encompass the evolution of telehealth over the preceding two decades, articles published between 1996 and 2017 were included. Articles were included if they were in English, published after 1996, participants were ED staff providing care or the patients receiving care, rural or remote ED settings, telehealth was used, presentations were non-critical emergencies, the full journal article could be assessed for analysis.

Articles were excluded if they reported on settings other than EDs, including pre-hospital care in ambulances or hospital ward settings, focussed on critical presentations, or evaluated telehealth in aeromedical evacuations. Review articles, single-case studies, editorial comments, conference proceedings, grey literature (such as non-commercial reports) and unpublished material were excluded.

Definitions and terminologies

Included articles were presumed to have a focus on non-critical presentations if there was no identifiable focus on critical presentations. Critical presentations included time critical presentations such as suspected stroke, acute coronary syndrome or trauma presentations. Articles relating to trauma presentations were excluded since the term is more commonly associated with critical presentations, rather than non-critical presentations. Additionally,

articles specifically focusing on aeromedical retrievals were also excluded on the assumption that patients would be critically ill, or injured if aeromedical retrieval was required.

In this review, EDs established in the rural or remote location were referred to as the peripheral site, while the larger hospitals providing the teleconsultations, or receiving patient transfers was referred to as the base hospital. The term tele-radiology was used to refer to instances in which an image generated by an imaging modality was transferred. Teleconsultation refers to an instance in which a telehealth consultation was provided via real-time videoconferencing (VC) technology to allow remote assessment, diagnosis and formulation of patient management plans.

Study selection

Following each database search, relevant articles were identified by scanning the title, or title and abstract. A low threshold for inclusion was applied and all articles discussing telehealth in emergency were downloaded into the citation manager (EndNote Version 7.5.3). Duplicates were removed and an abstract review was conducted by MdT to identify articles meeting eligibility criteria. Abstract selection was verified by RR to reduce bias introduced by single reviewer. If required, a full-text review was conducted to determine eligibility. Any disagreements between reviewers were resolved by consensus.

Abstraction and analysis

The relevance and quality of the selected articles were reviewed using the Critical Appraisal Skills Programme and a methodological quality assessment tool adapted from previous research (Table 1).[22-25] The level of evidence for each included study was determined according to the National Health and Medical Research Council (NHMRC) guidelines.[26] Selected articles were reviewed in full to identify recurring themes.

A framework for data extraction was developed by MdT and BMA. Management of non-critical emergencies was determined by evaluating telehealth model design, number of peripheral sites, clinicians involved and scope of service. Telehealth program outcomes

were assessed by considering the telehealth program uptake and total consultations, the effect on change in diagnosis or management plan and patient disposition including transfer, local hospital admission, discharge and discharge against medical advice. When available, any telehealth intervention outcomes were compared to outcomes of ED presentations when telehealth was not used.

Results

Searching strategies identified 2532 articles. Following an initial screen and duplicate removal, 396 articles remained. An additional 322 articles were excluded through title and abstract screening against eligibility criteria. Seventy-four full-text articles were assessed against eligibility criteria. Fifteen articles were included in the systematic review (Figure 1).

Article relevance, study methodology and general characteristics

The critical quality appraisal indicated considerable variation in methodology and academic rigor of study design (Table 1 and 2). Four articles were identified as significantly relevant to this review with a score above 67% and the remainder moderately significant with score between 34-66.9%. The overall quality appraisal score ranged from 36% to 81%, with an average quality appraisal score of 59.67% indicating moderate match of included articles with review objectives. Six studies were identified as pilot programs or trials.[4, 10, 27-30] Six articles originated from North America, four from Australia and the United Kingdom and one from Taiwan.[3, 4, 10, 27-38] Extracted data are presented in Table 3.

How telehealth programs assist in the management of non-critical emergencies

Telehealth program model. Ten studies described set-up of communication between the peripheral EDs and a base ED.[3, 10, 28-31, 33, 34, 36-38] In three studies, the base site was not an ED, but consultation with specialists at a base hospital.[27, 30, 32] In one article, peripheral EDs contacted the base, who subsequently contacted a third party hospital if admission was required.[35]

Scope of service and service provided. The identified scopes of service included tele-psychiatry, tele-ophthalmology and tele-emergency. Tele-psychiatry used telehealth to

assist with mental health emergency presentations and tele-ophthalmology accessed telehealth for acute eye concerns requiring ophthalmologist assessment.[27, 32, 35] Tele-emergency covered all general emergency presentations and teleconsultations were provided within all studies.[3, 4, 10, 28-31, 33-38] Six tele-emergency studies specifically described the utilisation of tele-radiology.[10, 28-31, 34] In two tele-emergency articles, other specialists or sub-specialists were consulted following initial consults with emergency doctors.[10, 28]

Participating health professionals. In most of the studies, telehealth was initiated by any emergency health care worker, but in six articles it was specifically initiated by a doctor.[11, 27, 28, 30-32] Telehealth support by the base site was generally provided by senior house officers, ED registrars or ED consultants. Only two articles indicated the calls were specifically received by an ED consultant.[4, 31] Tele-psychiatry and tele-ophthalmology assessments and management advice were provided by experts within the relevant field.[27, 32, 35] In the tele-psychiatry model, phone calls were initially received by mental health nurses, with subsequent teleconsultation and psychiatrist support, if required.[35] In the tele-ophthalmology studies, ED consultants contacted the ophthalmologists remotely to assess the patient via teleconsultation using a slit-lamp capable of transmitting high resolution images.[12, 32]

Outcomes of telehealth programs

Telehealth consultations and uptake of telehealth programs. The number of consultations ranged widely from 24-9048, as did the rate of uptake 0.8-40.5%.[3, 10, 27, 31, 32, 35, 37, 38]

Change in diagnosis or management plan. Five articles reported that telehealth influenced patient diagnosis or management in 18-66% of consultations.[4, 10, 27, 28, 30]

Patient transfer rates. Thirteen articles included a statement relating to the influence of telehealth on patient transfer rates which was reported to range from 6.3-54.2%.[3, 4, 10, 27-29, 31, 33-38] Only one article noted a reduction in the urgent and non-urgent transfers compared to a retrospective control group.[27] The remaining articles reported increases in patient transfers with the largest increase being from 1.1% to 54.2% post-implementation of the

telehealth program.[10, 35-38] Four studies aligned telehealth with reduction in unnecessary patient transfers in 8.5-77% of consultations.[10, 31, 34, 38]

Rates of discharge, discharge against medical advice and local hospital admission. Six articles provided information on these aspects of patient disposition and admission to local hospital was noted to range from 7.8-24%, while 18.4-80% of patients were discharged home following teleconsultation.[3, 10, 36-39] Following implementation of a telehealth program an increase was noted in local hospital admissions and less patients were discharged home compared to presentations in which telehealth was not used.[10, 36-38] Rates of discharge against medical advice ranged between 0.9% and 1.1% in the two articles which reported this variable.[3, 36]

Discussion

Our systematic review of the models of telehealth in the management of non-critical emergencies in rural or remote emergency departments identified several models of care, and outcome measures including rates of patient transfers, discharge and management at rural hospitals.

The most widely implemented telehealth model within this review appeared to be the hub and spoke model, where peripheral EDs connect to a large hub ED and assistance is provided via real-time teleconsultation from a hub ED physician, to health care staff at the peripheral ED.[16] The base hospital was generally staffed with board certified emergency physicians and ED-trained nursing staff, while the peripheral site was often staffed with nurse practitioners, physician assistants and GPs.[3, 4, 16, 31, 37]

A modified hub and spoke model could be implemented when teleconsultation was specifically requested from a specialist or subspecialist. In this model, the peripheral ED directly establishes a telehealth consultation with the specialist, as was the case for the tele-ophthalmology and tele-psychiatry articles.[16, 27, 32, 35] Specialist advice could also be organised by peripheral ED staff following an initial assessment by base ED.[10, 28] Protocols

can be implemented to describe the processes required to obtain the specialist teleconsultation. This modified model would allow for simplified access to specialist teleconsultation for all presentations via one port of call. Ultimately, the most suitable telehealth model to provide teleconsultations would be dependent on the support requirements of the rural and remote ED staff.

Rate of uptake of telehealth models seem to vary depending on whether doctors are available or not for advice locally. The rate of uptake was significantly higher in locations where nurses, or nurse practitioners were not supported by physicians within the peripheral ED and medical cover was predominantly, or solely provided by teleconsultation.[3, 4] Consistent with this, the rate of uptake was considerably lower when telehealth consults were initiated by a doctor. Higher rates of uptake were also noted when assistance were sought for specific presentations from experts within the field.[27, 35]

In one article, 98% of teleconsultations were initiated by nurses when the rural town's doctor was unavailable.[4] Alternatively, support could be provided by telehealth similar to the American Tel-Emergency program which was developed to successfully provide emergency care by nurse practitioners with no support from local doctors and assistance was primarily provided via teleconsultation.[3, 36] These nurse-led models may have other benefits related to shortage of medical officers. The on-call roster for rural hospital may be shared between a small number of doctors and can become burdensome; hence, in a small ED, if a nurse was able to provide appropriate management, the patient could be discharged without immediate review by a doctor.[40]

The impact of telehealth programs on patient disposition is dependent on the telehealth program design and rates of patient transfer, discharge, local admission and discharge against medical advice are closely linked. Previous research suggested patient transfer may be reduced with telehealth, yet the majority of studies analysed within this review reported increase in patient transfers. Three studies identified telehealth as useful for patient transfer coordination.[4, 28, 37] Base ED nursing staff who received teleconsultation calls assisted with remote documentation, allowing the peripheral staff to focus on providing patient care.[37] Telehealth was beneficial in facilitating patient transfer and assessing

patients or transfer information prior to transfer.[28, 37] Four studies aligned telehealth with reduction in unnecessary patient transfers in 8.5-77% of consultations.[10, 29, 31, 38] Even one of the studies with the highest transfer rate of 47.6% noted that transfer was avoided in 17% of teleconsultations.[38] Practitioner telehealth experience appears to impact transfer rates as decreased transfers were observed with increasing clinician confidence in providing remote assessment and management advice via telehealth.[33] Telehealth programs reduce the number of unnecessary transfers and secondary overtriage while increasing the capacity to manage a patient locally.[10, 11] This may well translate into increased local hospital admissions and reduced discharges following teleconsultation which was indeed apparent in this review. Increase in local admissions is likely to add extra burden on small rural hospitals especially when there is shortage of medical officers and understaffed EDs. While clinicians from larger centres who provide the telehealth services need to keep this mind, at system level, there is an opportunity to lobby for increased resources for rural towns to meet this need and demand. Rate of discharge against medical advice can be viewed as acceptability of a given program. The rate of discharge against medical advice was low, but further research into this is warranted.[36]

Limitations

This review may have been limited by selection, inclusion and publication bias. Articles generally did not provide injury severity scores, or specifically indicate if clinical presentations were critical, or non-critical. Selection bias may have resulted in the exclusion of relevant articles eg. exclusion of trauma presentations which are predominantly, but not always critical. The absence of injury severity scores meant no correlation between severity of presentation and increase in uptake can conclusively be established.

Additional challenges included the considerable variation in study design, sample sizes and reporting on analysed variables. True impact of telehealth programs was difficult to ascertain in the absence of control data in a number of studies. Meta-analysis was not viable due to lack of heterogeneity of methodology.

Conclusion

A hub-and-spoke, or modified hub-and-spoke model appears to be the most effective telehealth program set-up to provide teleconsultations for general ED presentations and to arrange appropriate specialist consultations. The uptake of a telehealth program appears to be dependent on whether medical support is available at a peripheral EDs. Providing remote diagnosis and management assistance when required may assist in increasing capacity to manage patients locally and reduce unnecessary transfers. Any extra burden arising as a result of increase in local admissions needs to be matched by allocation of extra resources to enhance rural capabilities.

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Table 1: Methodological Quality Assessment Tool for Critical Appraisal of Included Articles

Quality Assessment Items
Was the sample likely to be representative of the study population? Δ 1= an entire target population, randomly selected sample, sample stated to represent the target population, simple random sampling, systematic, stratified, cluster, two-stage or multi-stage sampling 0 = purposive, quota, convenience, snowball sampling or insufficient information on sampling strategy
Was a response rate, or drop-out rate or missing data mentioned within the study? Δ 1= response rate, drop-out rate or missing data addressed and reasons for it described; non-responders described; comparison of responders and non-responders or target population; no drop-out rate or missing data 0 = response rate, drop-out rate or missing data not addressed or described
Were data collection methods for qualitative study design reliable and adequately described? Δ 1= a validated questionnaire used or questionnaire at least tested for reproducibility; interview validated or tested for reproducibility; interview method adequately described and standardised; validated survey, tested for reproducibility, adequately described or standardised 0 = qualitative methodology not adequately described or not tested for reliability =/X
Were quantitative data collection methods reliable and adequately described? Δ 1= data collection methods adequately described, tested for reproducibility, analysis methods described 0=quantitative methodology not well described
Was it a primary data source? 1 = data primary data relating to telehealth within EDs 0 = Data was collected via proxy or from secondary source or survey not designed specifically for the purpose of collecting the data relating to telehealth within EDs
Did article specifically relate to non-critical emergency presentations? Δ 1 = included definition of non-critical emergencies, or specifically indicated majority of presentations were non-critical emergencies 0.5 = enough information within article to confidently ascertain the majority of presentations were non-critical emergencies 0 = inadequate information on nature of presentations but eligibility criteria met
Relevance
Relevance to Review Question 1: How has telehealth been used to manage non-critical emergency presentations? 1 = adequate description of telehealth model, number of peripheral sites and base site, as well as communicating clinicians 0 = telehealth model not adequately described
Relevance to Review Question 2: What were the telehealth program outcomes in terms of number of telehealth consultations, uptake of the program, effect on diagnosis and/or management plan, effect on transfer rates and effect on patient disposition (discharged, local admission and discharged against medical advice)? 1 = substantial or adequate information on the outcomes following implementation of telehealth program, or only one category of outcomes unavailable 0.5 = < 3 categories of outcomes not available from article 0 = ≥3 categories of outcomes not available from article
Score: ϕ

Sub Notes:

Δ At least one of the following must apply within the study; /X = Question not relevant to article and will be excluded from analysis; ϕ Total score calculated by dividing the total number of relevant items multiplied by 100; Quality appraisal score and match with the objectives of current review: Weak: 0-33.9%; Moderate: 34-66.9%; Strong: 67-100%

Table 2: Comprehensive Summary of Article Characteristics

Article	Location	Scope of Service	Duration	Number of Sites	Communicating Clinicians	Study Methodology and Design	Level of Evidence
Armstrong & Haston 1997	Scotland, United Kingdom	Tele-Emergency Tele-radiology Tele-consultation	12 months	1 PED and 1BED	GP to ED Consultant	**Mixed methods** *Quantitative* Descriptive statistics *Qualitative* Satisfaction survey (5 points with free text entries) Retrospective Study E = 120 (cases in which telehealth used); C= No Control	IV
Blackwell *et al.* 1997	Queensland, Australia	Tele-Ophthalmology	3 months	1 PED and 1 BS	ED Consultant to Ophthalmologist	**Mixed Methods** *Quantitative* Descriptive statistics *Qualitative* Methodology not well explained Prospective Cohort Study without concurrent control E = 264 (Total ED presentations with acute eye conditions) C = 315 (Retrospective control group during same time period in preceding year)	III-3
Rosengren *et al*. 1998	Queensland, Australia	Tele-Ophthalmology	3 months	1 PED and 1 BS	ED Consultant to Ophthalmologist	**Qualitative** Retrospective telephone survey and structured interview Retrospective analysis with no concurrent control E = 337 (Total ED Presentations with ophthalmological complaints during study period); C = No Control	IV
Lee *et al.* 1998	North Carolina, United States	Tele-Emergency Tele-Radiology	12 months	1 PED and 1BS	Doctor (ED consultant or GP or Internal medicine) to radiology registrar or Radiologist	**Quantitative** Descriptive statistics of teleconsultations E = 90; C = No Control	IV
Chi *et al.* 1999	Tainan, Taiwan	Tele-Emergency Specialist advice Tele-radiology	12 months	4 PEDs and 1 BED	ED Physician to physician +/- Specialist	**Quantitative** Descriptive statistics of telehealth program use and user satisfaction survey Retrospective case series with post-test outcomes E = 275; C = No Control	IV
Stamford *et al.* 1999	North Carolina, United States	Tele-Emergency Tele-radiology Specialist advice	12 months	1 PED and 1 BED	Physician to physician or specialist	**Quantitative** Descriptive analysis following telehealth intervention by review of data log and questionnaire Retrospective case series with post-test outcomes E=118; C = 7141 (Total Ed presentations during same period for which teleconsultation was not used)	IV

Article	Location	Scope of Service	Duration	Number of Sites	Communicating Clinicians	Study Methodology and Design	Level of Evidence
Brebner *et al.* 2002	Scotland, United Kingdom	Tele-Emergency Teleradiology	15 months	4 PEDs and 1 BED	Physician or Nurse to ED Physician	**Mixed Methods** *Quantitative* Descriptive analysis of logbook data and user satisfaction assessment by Likert scale *Qualitative* Methods not described Retrospective Cohort study E = 402; C = No Control	IV
Ferguson *et al.* 2003	Scotland, United Kingdom	Tele-Emergency	6 months	14 PEDS and 1 BED	GPs and nurse practitioners (81%) to physicians (specialist registrars and experienced SHOs)	**Quantitative** Descriptive statistics Prospective cohort study E = 407 C = No Control	III-2
Brebner *et al.* 2004	Scotland, United Kingdom	Tele-Emergency Teleradiology	12 months	14 PEDS and 1 BED	Physician or nurse to Physician	**Mixed Methods** *Quantitative* Descriptive statistics User satisfaction assessment by five point semantic differential scale (82% response rate) *Qualitative* Interviews with 2 staff members at each site, pre/post study. Qualitative methodology not well explained Prospective cohort study E = 1392; C = No Control	IV
Galli *et al.* 2008	Mississippi, United States	Tele-Emergency	36 months	11 PEDs and 1 BED	Nurse Practitioner to ED Physician	**Quantitative** Review of recorded telehealth data Questionnaire for hospital administrators (72.7% response rate – 8 of 11 hospitals) Periodic surveys of patient satisfaction (2% response rate – 434 responses) **Note** in this study NPs attend to low triage patients and all presentations which are more complicated are attended to by Telehealth. Assumption therefore made that all patients admitted and transferred because of telehealth. Retrospective cohort study E = 16200 (ED presentations in which teleconsultations occurred); C = 23800 (ED presentations managed by NP only)	III-3

Article	Location	Scope of Service	Duration	Number of Sites	Communicating Clinicians	Study Methodology and Design	Level of Evidence
Herrington *et al.* 2013	Western Australia, Australia	Tele-Emergency	11 months	Initially 6 PEDs and followed by expansion to 25 PEDs, BS not specified	Doctor or nurse (98%) to ED Consultant	**Quantitative** Descriptive statistics Case Series with post-test outcomes E = 3000 C = No Control group	IV
Saurman *et al.* 2014	New South Wales, Australia	Tele-psychiatry Initial telephone consultation with follow-up VC if required	12 months	48 PEDs and 1 BS not specified	Doctor or Nurse to Mental Health Nurse and Psychiatrist	**Quantitative** Descriptive analysis of routinely-collected data Retrospective Cohort study E = 1487; C = N/A	III-3
Sterling *et al*. 2016	Mississippi, United States	Tele-Emergency	24 months	9 PEDs and 1 BED	Nurse Practitioners to ED Physician	**Mixed Methods** *Quantitative* Descriptive analysis of rural hospital questionnaire Nurse practitioner survey with preselected answers and free text option E = 5174 (median) Post-Implementation of telehealth C = 5563 (Median) Pre-Implementation of telehealth Note above numbers represent medial total ED presentations and does not specifically indicate if telehealth was used in every ED presentation	III-3
Ward *et al*. 2016	Several states, United States	Tele-Emergency	19 months	26 PEDs and BED not clearly specified	Physician/nurse practitioner/Physician assistant to Physician or nurse	**Mixed methods** *Quantitative* Descriptive analysis of telehealth data log and electronic medical records *Qualitative* Semi-structured interviews with 35 medical administrators and 46 clinicians at 26 rural hospitals with minimum 6-month use of telehealth program Retrospective Cohort Study E = 1512; C = 58681 (Total ED presentations during same duration for which teleconsultation was not activated)	III-3
Natafgi *et al.* 2017	Several states, United States	Tele-Emergency	52 months	85 PEDs and BED not clearly specified	Physician/Nurse/ physician assistant to physician or nurse[37]	**Quantitative** Descriptive analysis of telehealth data Retrospective study E = 9048; C = 164,291 (Total ED presentations during same period for which telehealth was not activated)	III-3

PED = Peripheral ED, BED = Base ED, BS = Base site, E = Experimental Group (Telehealth Used), C = Control group, N/A = Not Available

Table 3: Comprehensive Summary of Data Extraction

Article	Number of Telehealth Consultations	Uptake of Tele-health Program (%)	Change in Diagnosis or management plan	Patient Transfer Rates	Patient Discharge, Local Admission and Discharge Against Medical Advice Rates
Armstrong & Haston 1997	120 telehealth consultations 76 VC (63%) 4 Telepresence (3%)	0.8%*	NS	Transfer avoided in 70 patients (58%)	NS
Blackwell *et al.* 1997	24 teleconsultations	9.1%	Change in management plan 10 (41.7%)	Urgent transfer E = 1.5% C = 5.4% Non-urgent transfer E = 11.4% C = 13%	NS
Rosengren *et al*. 1998	24 teleconsultations	7.12%	No change in diagnosis 6 months after initial consultation	NS	NS
Lee *et al.* 1988	90 teleradiology consultations (68%)	NS	Change in diagnosis 27 (30%) and confirmation of initial impression in 62 (69%) Change in management 23 (26%)	NS	NS
Chi *et al.* 1999	275 teleconsultations	NS	Establish diagnosis 153 (55.6%) Confirm diagnosis 54 (19.6%)	E = 20 (7.3%) Pre-transfer consultation and transfer of data in 12(5.1%)	NS
Stamford *et al.* 1999	118 telehealth consultation cases consisting of 34 teleconsultations and 90 teleradiology consultations (some patients had both consultations types)	1.7%*	*Change in Diagnosis* teleconsultation 6 (18%) Teleradiology 24 (27%) *Change in Management Plan* Teleconsultation 18 (52%) Teleradiology 22 (24%) C = N/A	Teleconsultation 11 (32%) teleconsultation 9 (10%) teleradiology Transfers avoided due to telehealth 10 (8.5%) C = 360 (5%)	*Patient local admission* E = 5 (15%) Teleconsultation C = 563 (7.9%) Other NS
Brebner *et al.* 2002	402 teleconsultations teleradiology (87%)	NS	NS	E = 11%	NS
Ferguson *et al.* 2003	407 teleconsultations	NS	NS	E = 29% (Median transfer rate) (Overall transfer rate for clinicians providing telehealth advice reduced from first 3 month period to second three month period : 31% to 23%)	NS
Brebner *et al*. 2004	1392 teleconsultations	NS	NS	E = 320 (23%) transfers E = 1072 (77%) avoided transfers	NS

Article	Number of Telehealth Consultations	Uptake of Tele-health Program (%)	Change in Diagnosis or management plan	Patient Transfer Rates	Patient Discharge, Local Admission and Discharge Against Medical Advice Rates
Galli et al. 2008	16200 teleconsultations	40.5%	NS	E = 18.3% C = 0	*Discharge Rate* C + E = 62% *Local Admission* E = 18.2% C = 0 *Discharge Against Medical Advice* C + E = 0.9%
Herrington *et al.* 2013	3000 teleconsultations	NS	Remote diagnosis and management in 2000 (66%)	E = 700 (23.3%)	NS
Saurman *et al.* 2014	1487 telephone consultations 571 VC consultations (38% of contacts)	Estimated 25-33% of mental health ED presentations	Not Specified Request for assistance with specific presentation	E = 299 (20.1%) vs 134 (9.0%) Total consultations vs VC consultations	*Discharge Rate* E = 986 (66.3%) *Local Admission* E = 177 (11.9%) vs 116 (7.8%) Total consultations vs VC consultations *Discharge Against Medical Advice* NS
Sterling *et al.* 2016	Number of consultations E = 5141 C = 5563 p-value = 0.820	NS	NS	E = 6.6% C = 6.3 (p-value = 0.098)	*Discharge Rate* E = 80.0% C = 87.1% (p-value = 0.004) *Local Admission* E = 8.1% C = 6.7% (p-value = 0.023) *Discharge Against Medical Advice* E = 1.1% C = 0.3% (p-value = 0.004)
Ward *et al.* 2016	1512 teleconsultations	Average activation rate 3.5%	NS	E = 819 (54.2%) C = 598 (1.1%)	*Discharge Rate* E = 278 (18.4%) C = 45131 (81.0%) *Local Admission* E = 363 (24%) C = 9267 (16.6%) *Discharge Against Medical Advice* NS
Natafagi *et al.* 2017	9048 teleconsultations	5.5%*	NS	E = 4224 (47.6%) Transfers E = 1175 (17%) Avoided transfers C = 1059 (0.7%)	*Discharge Rate* E = 2075 (23.4%) C = 138,758 (88.2%) *Local Admission* E = 2078 (23.4%) C = 6634 (4.2%) *Discharge Against Medical Advice* NS

VC = Videoconference, N/A = Not Available, E = Experimental Group (Telehealth Used), C = Control group, NS = Not Specified, * = Calculated

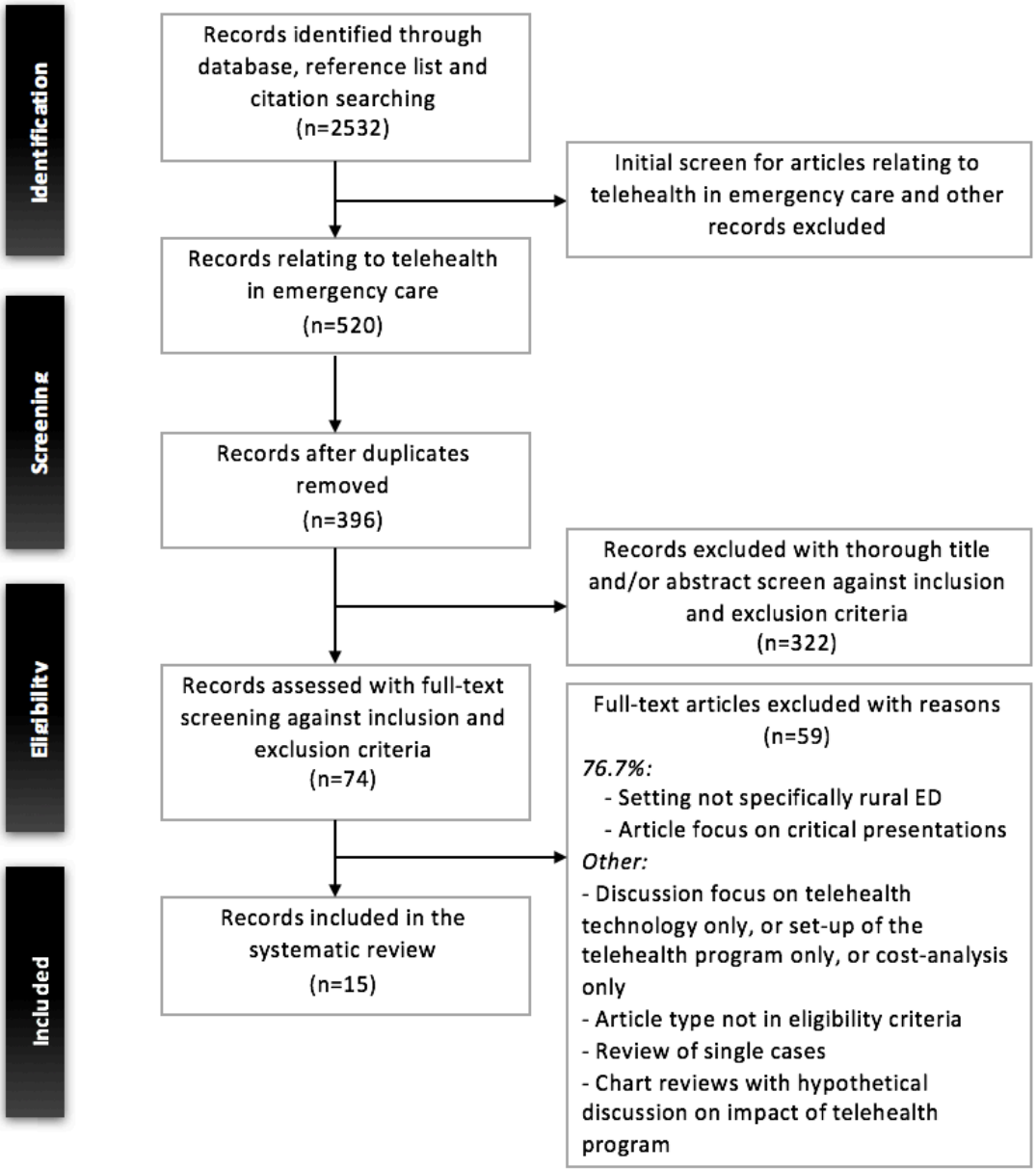

Figure 1. Flow Diagram for the Process of Study Selection