CANADIAN STROKE BEST PRACTICE RECOMMENDATIONS

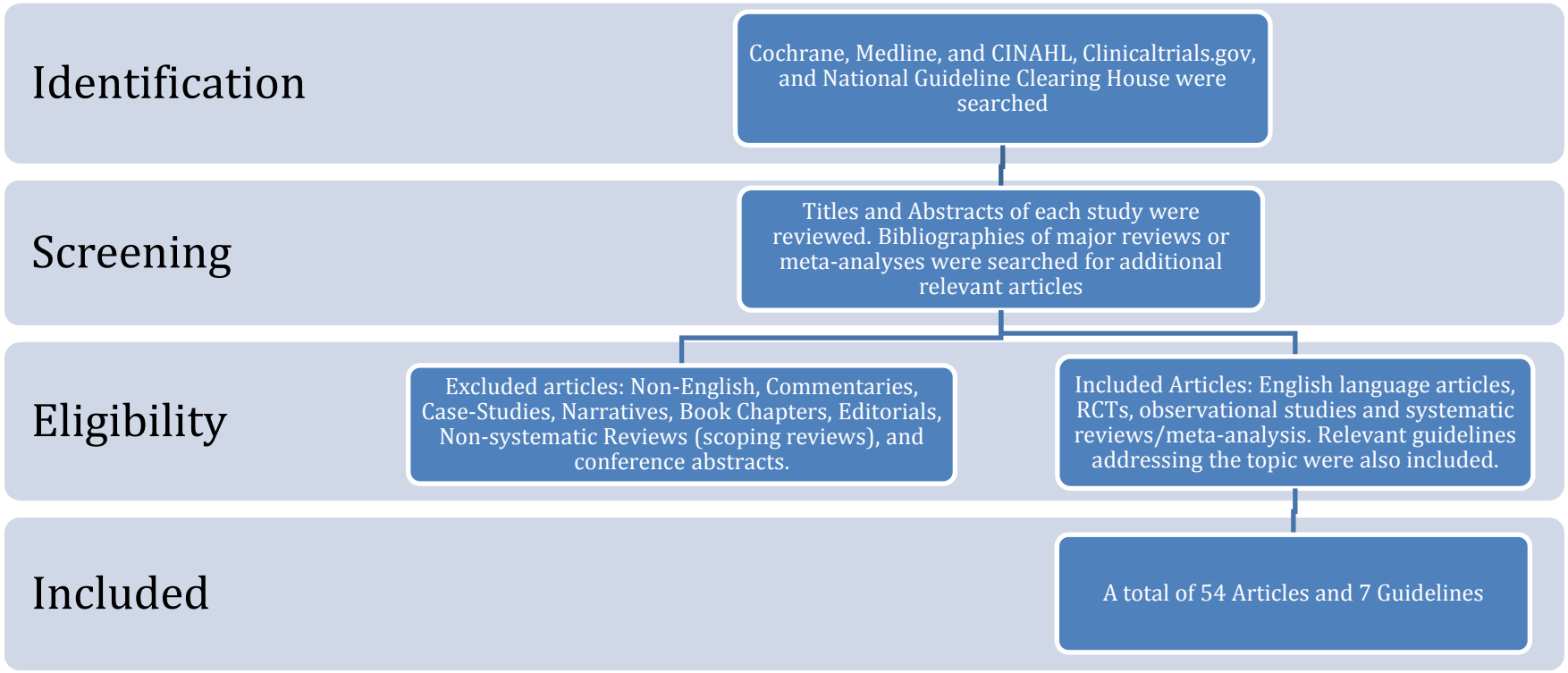
Telestroke

Evidence Tables

Dylan Blacquiere, Frank L. Silver (Writing Group Chairs)
on Behalf of the Canadian Stroke Best Practice Recommendations
Telestroke Writing Group

Table of Contents

Search Strategy



Cochrane, Medline, and CINAHL, Clinicaltrials.gov, and National Guideline Clearing House were search using medical subject. Titles and abstract of each article were reviewed for relevance. Bibliographies were reviewed to find additional relevant articles. Articles were excluded if they were: non-English, commentaries, case-studies, narrative, book chapters, editorials, non-systematic review, or conference abstracts. Additional searches for relevant best practice guidelines were completed and included in a separate section of the review.

Published Guidelines

Guideline	Recommendations
Jauch EC, Saver JL, Adams HP Jr, Bruno A, Connors JJ, Demaerschalk BM, Khatri P, McMullan PW Jr, Qureshi AI, Rosenfield K, Scott PA, Summers DR, Wang DZ, Wintermark M, Yonas H; on behalf of the American Heart Association Stroke Council, Council on Cardiovascular Nursing, Council on Peripheral Vascular Disease, and Council on Clinical Cardiology. **Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association.** **Stroke 2013;44:870–947.**	**Designation of Stroke Centers and Stroke Care Quality Improvement Process:** - For sites without in-house imaging interpretation expertise, teleradiology systems approved by the Food and Drug Administration (FDA) or equivalent organization are recommended for timely review of brain CT and MRI scans in patients with suspected acute stroke (Class I; Level of Evidence B). (New recommendation) - When implemented within a telestroke network, teleradiology systems approved by the FDA (or equivalent organization) are useful in supporting rapid imaging interpretation in time for fibrinolysis decision making (Class I; Level of Evidence B). (New recommendation) - Implementation of telestroke consultation in conjunction with stroke education and training for healthcare providers can be useful in increasing the use of intravenous rtPA at community hospitals without access to adequate onsite stroke expertise (Class IIa; Level of Evidence B). (New recommendation) - The creation of ASRHs can be useful (Class IIa; Level of Evidence C). As with PSCs, the organization of such resources will depend on local resources. The stroke system design of regional ASRHs and PSCs that provide emergency care and that are closely associated with a CSC, which provides more extensive care, has considerable appeal. (New recommendation)
Intercollegiate Stroke Working Party. National clinical guideline for stroke, 5th edition. National Institute for Health and Clinical Excellence London: Royal College of Physicians, 2016.	**G** Where telemedicine is used for the assessment of people with suspected stroke by a specialist physician, the system should enable the physician to discuss the case with the assessing clinician, talk to the patient and/or family/carers directly and review radiological investigations. Telemedicine should include a high-quality video link to enable the remote physician to observe the clinical examination. **H** Staff providing care via telemedicine (at both ends of the system) should be appropriately trained in the hyperacute assessment of people with suspected acute stroke, in the delivery of thrombolysis and the use of this approach and technology. The quality of care and decision-making using telemedicine should be regularly audited.
Scottish Intercollegiate Guidelines Network (SIGN). Management of patients with stroke: rehabilitation,	In areas without a local stroke specialist, telemedicine consultation should be considered to facilitate treatment in patients eligible for thrombolysis (Evidence Level B).

Guideline	Recommendations
prevention and management of complications, and discharge planning. A national clinical guideline. Edinburgh (Scotland): Scottish Intercollegiate Guidelines Network (SIGN); 2010 June.	
Guidelines for Management of Ischaemic Stroke and Transient Ischaemic Attack 2008. The European Stroke Organization (ESO) Executive Committee and the ESO Writing Committee.	It is recommended that in remote or rural areas telemedicine should be considered in order to improve access to treatment (Evidence Level: Class II, Level B). The development of clinical networks, including telemedicine, is recommended to expand access to high technology specialist stroke care (Evidence Level: Class II, Level B).
Clinical Guidelines for Stroke Management 2010. Melbourne (Australia): National Stroke Foundation; 2010.	• All health services which include regional or rural centres caring for stroke patients should use networks which link large stroke specialist centres with smaller regional and rural centres (Evidence Level C). • These networks should be used to help establish appropriate stroke services along with protocols governing rapid assessment, telestroke services and rapid transfers (Evidence Level C). • Where no on-site stroke medical specialists are available, telestroke consultation should be used to assess eligibility for acute stroke therapies and/or transfer to stroke specialist centres (Evidence Level B).
Schwamm LH, Holloway RG, Amarenco P, Audebert HJ, Bakas T, Chumbler NR, Handschu R, Jauch EC, Knight WA IV, Levine SR, Mayberg M, Meyer BC, Meyers PM, Skalabrin E, Wechsler LR; on behalf of the American Heart Association Stroke Council and the Interdisciplinary Council on Peripheral Vascular Disease. **A review of the evidence for the use of telemedicine within stroke systems of care: a scientific statement from the American Heart**	**Class I recommendations** 1. High-quality videoconferencing systems are recommended for performing an NIHSS-telestroke examination in nonacute stroke patients, and this is comparable to an NIHSS-bedside assessment. Similar recommendations apply for the European and Scandinavian Stroke scales (Class I, Level of Evidence A). 2. The NIHSS-telestroke examination, when administered by a stroke specialist using high-quality videoconferencing, is recommended when an NIHSS-bedside assessment by a stroke specialist is not immediately available for patients in the acute stroke setting, and this assessment is comparable to an NIHSS-bedside assessment (Class I, Level of Evidence A). 3. Teleradiology systems approved by the FDA (or equivalent organization) are recommended for timely review of brain CT scans in patients with suspected acute stroke (Class I, Level of Evidence A). 4. Review of brain CT scans by stroke specialists or radiologists using teleradiology systems approved by the FDA (or equivalent organization) is useful for identifying exclusions for thrombolytic therapy in acute stroke patients (Class I, Level of Evidence A). 5. When implemented within a telestroke network, teleradiology systems approved by the FDA (or equivalent organization) are useful in supporting rapid imaging interpretation in time for thrombolysis decision making (Class I, Level of Evidence B).

Guideline	Recommendations
Association/American Stroke Association. ***Stroke* 2009;40:2616 –2634.**	6. It is recommended that a stroke specialist using high-quality videoconferencing provide a medical opinion in favor of or against the use of intravenous tPA in patients with suspected acute ischemic stroke when on-site stroke expertise is not immediately available (Class I, Level of Evidence B). 7. When the lack of local physician stroke expertise is the only barrier to the implementation of inpatient stroke units, telestroke consultation via high-quality videoconferencing is recommended (Class I, Level of Evidence B). 8. Assessment of occupational, physical, or speech disability in stroke patients by allied health professionals via high-quality videoconferencing systems using specific standardized assessments is recommended when in-person assessment is impractical, the standardized rating instruments have been validated for high-quality videoconferencing use, and administration is by trained personnel using a structured interview (Class I, Level of Evidence B). 9. Telephonic assessment for measuring functional disability after stroke is recommended when in-person assessment is impractical, the standardized rating instruments have been validated for telephonic use, and administration is by trained personnel using a structured interview (Class I, Level of Evidence B). **Class II recommendations** 1. High-quality videoconferencing is reasonable for performing a general neurological examination by a remote examiner with interrater agreement comparable to that between different face-to-face examiners (Class IIa, Level of Evidence B). 2. Implementation of telestroke consultation in conjunction with stroke education and training for healthcare providers can be useful for increasing the use of intravenous tPA at community hospitals without access to adequate onsite stroke expertise (Class IIa, Level of Evidence B). 3. Compared with traditional bedside evaluation and use of intravenous tPA, the safety and efficacy of intravenous tPA administration based solely on telephone consultation without CT interpretation via teleradiology are not well established (Class IIb, Level of Evidence C). 4. Prehospital telephone-based contact between emergency medical personnel and stroke specialists for screening and consent can be effective in facilitating enrollment into hyperacute neuroprotective trials (Class IIa, Level of Evidence B). 5. Delivery of occupational or physical therapy to stroke patients by allied health professionals via high-quality videoconferencing systems is reasonable when in-person assessment is impractical (Class IIa, Level of Evidence B).

Evidence Tables

Safety and Feasibility of Telestroke Systems

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Legris et al 2016 **France** **Controlled study**	NA	9 spoke sites that met criteria for participation (24-hr ED with access to brain imaging, standardized best-practice based procedures for the use of thrombolysis, and 2-day training for staff at the hub hospital) and 2 hub hospitals with stroke units in the Burgundy region.	Outcomes of patients who received thrombolysis therapy via telestroke system from 2012-2014 (and who were subsequently transferred to the hub hospital, n=132) were compared with patients who received thrombolysis therapy at the hub centre (n=222) from 2011-2012.	NIHSS scores at 24 hours post treatment, mortality, complications (any ICH, symptomatic ICH, malignant cerebral edema, mRS at 3months	7 patients in the telestroke group and 21 patients in the hub hospital group underwent endovascular therapy with a stent retriever. Patients in the telestroke group received this treatment after transfer to the hub hospital. Median 24-hour NIHSS scores were nom-significantly higher in the telestroke group (8 vs. 6, p=0.06). Median discharge NIHSS scores were significantly lower in the hub group (4.5 vs. 3, p<0.001). In-hospital death was significantly higher in the telestroke group (13.6% vs. 6.3%, p=0.02). Frequency of complications was similar between groups. The proportion of patients with mRS 0-1 at 3 months was significantly higher in the hub group (35.6% vs. 48.6%, p=0.02). The proportions of patients with mRS of 0-2 or who were dead at 3 months were similar between groups (51.5% vs. 55.9%, p=0.43 and 18.95 vs. 16.5%, p=0.56, respectively).
Switzer et al. 2014 **USA** **Retrospective study**	NA	2 hub hospitals (one in Georgia, one in South Carolina) with 32 spoke hospitals, that used the REACH telemedicine platform	The outcomes of patients who received t-PA within 32 spoke hospitals, were compared	Variations in t-PA usage across spoke hospitals, and predictors of t-PA use	The mean adjusted t-PA usage was non-significantly higher at the telestroke network based in Georgia (3.98 vs. 2.96, p=0.15 administrations/10,000 ED visits/yr.). There was large variability across all spoke hospitals in t-PA usage, ranging from 0.85-8.74 administrations/10,000 ED visits/yr. Spoke hospital with the availability of a stroke nurse co-ordinator had higher t-PA use (4.61 vs. 2.84, p=.03).

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					There were no associations between any of the other variables examined at spoke hospitals and t-PA use, including designation as a primary stroke centre, availability of a neurologist for post-tPA consultation, hospital size (<100 beds vs. ≥100 beds), local neurology support (community neurologists vs. neurohospitalists), whether fees were paid by spoke hospitals to hub hospitals, and whether spoke hospitals solicited the hub hospitals for services or were solicited by the hub.
Agarwal et al. 2014 **UK** **Retrospective study**	NA	7 district hospitals in East England providing out-of-hours access to thrombolysis on weekends and evenings, delivered by 10 stroke specialists, using a telemedicine cart (pc + high-resolution CCTV camera, with videoconferencing software).	During the pilot phase, which included 4 regional hospitals (Sept 2009-Jan 2010), there were 43 telestroke consults. Between Nov 2010 and 2011, 142 telemedicine consults were conducted	Number of patients treated with t-PA, time to treatment, symptomatic ICH (sICH), in-hospital mortality	Pilot phase: 15 patients (35%) received thrombolysis. Mean age of patients was 72 years. Median NIHSS score was 13, mean onset-to-needle time was 131 minutes. There were no sICHs. Beyond the pilot phase, 74 patients (52.1%) received thrombolysis. Mean age of patients was 69 years. Median NIHSS score was 10, median onset-to-needle time was 169 minutes. 7.3% of patients experienced an sICHs and in-hospital mortality was.8.1%.
Pedragosa et al. 2009 **Spain** **Retrospective study**	NA	A telemedicine system, which linked the neurologist at a stroke centre with a community hospital using videoconferencing was established to provide consultation for potential treatment with tPA when the neurologist at the community hospital was not available. 201 patients with acute stroke were admitted to hospital in 2006, before	Outcomes of patients admitted to the community hospital before and after the implementation of a telemedicine system were evaluated.	**Outcomes for all patients:** percentage of patients with ambulance transfer to stroke centre, % of patients with neurologist evaluation, % of unnecessary transfers to stroke centre (defined as patients who were retransferred to their hospital within 24 hours having not received tPA), % of patients admitted to the stoke unit, % of patients receiving tPA.	More patients were treated with tPA following the implementation of the telemedicine service (9 vs. 19, p=0.073). **All patients with stroke:** Following implementation, there was a significant decrease in the number of patients needing urgent ambulance transfer to the stroke centre (17% vs. 10%, p=0.04) and unnecessary transfers to the stroke centre (51% vs. 20%, p=0.02). There was an increase in the number of patients receiving neurological evaluation (17% vs. 38%, p<0.01). **Only patients receiving tPA:** Following the implementation, there was a significant decrease in the mean time from symptom onset to treatment (210 min vs. 162 min; p=0.05), an increase in the percentage of

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
		the telemedicine system was established and 198 patients were admitted in 2007.		**Outcomes for only patients treated with t-PA:** discharge NIHSS score, number of symptomatic and asymptomatic hemorrhagic strokes	patients treated within the 3-hour window (30% vs. 68%, p=0.04) and in the percentage of patients treated at the local hospital (0% vs. 63%, p=0.001). There were no significant differences before and after the implementation of the program for median NIHSS discharge score (5 vs. 4, p=0.96) or percentage of patients with symptomatic or asymptomatic hemorrhages (0% vs. 0%, p=1.00, and 20% vs. 22%, p=0.89 respectively). Data from the satisfaction survey found that patients reported benefits from the telemedicine system and physicians found it helpful.
Vaishnav et al. 2008 **USA** **Retrospective study**	NA	Emergency physicians from rural hospitals contacted a stroke neurologist at a tertiary care hospital via telephone. A decision to treat with tPA was made, based on the results of a structured interview, including verbal reports of CT findings, laboratory and clinical, Patients treated with tPA were shipped to the referral centre for ongoing monitoring and treatment.	The outcomes of 123 patients who received tPA were reviewed.	Time from stroke onset to tPA, time from stroke onset to arrival at community hospital, symptomatic & asymptomatic intracerebral hemorrhage (aICH, sICH) and mortality during hospital stay. Time points of assessment: sICH confirmed by a CT scan at 24 hours.	Mean ±sd time from stroke onset to: Arrival at rural hospital: 54±30 min administration of tPA: 133±37 min. 3 patients (2.4%) experienced sICH 11 patients (8.9%) experienced an aICH 9 patients (7.3%) died The authors compared results to other similar studies and found comparable results (NINDS study and SITS-MOST study).
Choi et al. 2006 **USA** **Retrospective study**	NA	A telestroke system using videoconferencing was set up between two remote hospitals and a central hospital with stroke expertise. Transfer to specialized stroke centre was arranged, if necessary.	The outcomes of 14 patients who had been admitted to a rural hospital and were treated with tPA within 3 hours of symptom onset following a telemedicine consult, were reviewed. tPA utilization rates during the previous 13 months and after the	Number of patients treated with tPA, time to treatment, 24 hour-NIHSS score, hemorrhagic complications.	During the implementation of the telemedicine system, 14/328 (4.3%) of patients received tPA, compared to 2/327 (0.81%) of patients prior to the implementation of the project (P<0.001). Median time from arrival at ER to tPA administration: 85 min (range 27-165 min). Time to treatment: 85 minutes (Range 27-165). NIHSS score: 50% of patients experienced improvements in NIHSS score (defined as ≥4-point

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			implementation of the telestroke system were also evaluated.		increase). 2% of patients experienced a decrease in NIHSS score. Hemorrhagic complications: no patients experienced any complications during the study period.
Waite et al. 2006 **Canada** **Retrospective study**	NA	6 neurologists from 4 sites of 2 academic stroke centres provided video consultation to 2 rural hospitals	The 88 patient consultations conducted during the first 34 months of the program, were reviewed.	Number of telestroke consultations, % of patients receiving thrombolysis treatment.	27(30%) of patients received thrombolysis. The majority of calls were received outside of regular business hours (Mon-Fri, 0900-1700 hrs) Minor problems with technology were reported, as were delays in accessing images.
Audebert et al. 2005 ***TEMPiS (Telemedic Pilot Project for Integrative Stroke Care):*** **Germany** **Retrospective study** **Muller-Barna et al. 2014** **Retrospective study** **10-year outcomes**	NA	A telemedicine system, using videoconferencing to enable 24 hour consultations with neurologists, was set up between 12 community hospitals and 2 specialized stroke centres. Interhospital transfers were centrally coordinated.	The outcomes of 106 patients admitted to hospitals who had been treated with tPA using the telemedicine system, were evaluated.	In-hospital mortality, inpatient length of stay, intracranial hemorrhage (ICH). Assessments were conducted at 36 hours (CT scan for ICH) and at discharge (death and length of stay).	Mean ±sd time from stroke onset to administration of tPA: 141±27 mins Mortality: 10.4% of patients died in hospital. Inpatient length of stay: median length of stay in hospital was 12 days. Intracranial Hemorrhage: 25% of patients experienced hemorrhages based on the CT scan within 36 hours of treatment with tPA. **10-year outcomes:** The number of consultations increased from 1928 (2003) to 4513 (2012). Recommendations for transfers from regional hospitals to stroke centres decreased significantly from 11.5% (2003) to 7.0% (2012), p<0.001. The number of patients treated with thrombolysis increased over the study period from 2.6% of all patients admitted to hospital with ischemic stroke in 2003 to 15.5% in 2012. Median onset-to-treatment time decreased significantly from 150 to 120 minutes (p<0.001). 7-day mortality following treatment with thrombolysis

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					remained stable over the study period (6.3%, p for trend =0.12).
Hess et al. 2005 **USA** ***Remote Evaluation of Acute isChemic Stroke (REACH)*** **Clinical feasibility study**	NA	A rural hub & spoke telestroke model including 8 hospitals in Georgia was developed in 2003. The system included 2-way audio and 1-way video.	194 stroke consults originating between March 2003 and Feb 2005 were reviewed.	Number of patients treated with tPA, onset to treatment (OTT) time, presence of hemorrhage, time to treatment, of symptomatic ICH (sICH), in-hospital mortality	30 patients (15.5%) received t-PA. mean age was 62 years. 60% were female. Mean baseline NIHSS score was 15.4, median 12.5. Mean OTT was 122 minutes, 60% of patients were treated within 2 hours of stroke. There were no incidences of sICH. In-hospital mortality was 7%. 29 patients were not treated with t-PA because they were initially seen beyond the time window.
Schwamm et al. 2004 **USA** **Retrospective study**	NA	A telestroke system using videoconferencing was set up between an island-based hospital and a specialized stroke centre to enable consultations between ER MDs and stroke neurologists, 24 hours/day.	Data from 24 patients admitted with acute ischemic stroke and assessed using the telestroke system over the 27-month study period, were reviewed. tPA utilization rates 2 years before and after the implementation of the telestroke system were also evaluated. A total of 106 patients were admitted to the ER with acute ischemic stroke during the time when telestroke services were available and 100 patients presented before the system was implemented.	Number of patients treated with tPA, presence of hemorrhage, time to treatment, and patient and physician satisfaction.	8/24 patients were eligible for tPA treatment. Of these, 6 were treated with tPA. Significantly more patients received tPA after telestroke was implemented (6 vs. 0, p=0.03). Hemorrhage: One patient had asymptomatic ICH; one patient had symptomatic ICH. Time from symptom onset to treatment: 142 ±20 min. Satisfaction: More than 96% of physicians and neurologists were satisfied with the quality of the videoconferencing, with their confidence in managing patients within this system of care, and believed that the system improved patient care. 85.7% of patients felt the system was equally as good as a face-to-face encounter.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
La Monte et al. 2003 **USA** **Retrospective study**	NA	A single regional stroke centre provided acute stroke consultations that could be initiated by any healthcare provider in the state using hospital-based telephone and video conferencing systems.	Review of 50 consultations from 1999-2001.	% of patients treated with thrombolytic agents, adverse events.	21 patients were managed using teleconference. Of these, 5 (23.8%) received t-PA. No complications associated with treatment were reported. Diagnoses based on videoconferences included ischemic stroke, SAH, ICH, TIA, seizure and hypoglycemia. 27 consultations were conducted using the telephone (2 were aborted due to technical difficulties) and 21, using videoconsultations. Main reasons for not using videoconsultations were: attending physician not on site where telemedicine equipment was located, patients> 3 hours of symptom onset, exclusion from thrombolysis therapy made based on clinical assessments. Staff and patients expressed satisfaction with the service.
Wiborg et al. 2003 **Germany *Telemedicine in Stroke in Swabia (TESS)* project** **Retrospective study**	NA	7 rural hospitals and a single stroke unit connected via a video conferencing system. 623 patients were admitted with a diagnosis of stroke during the study period (March 2001-Sept. 2002).	In the rural hospitals, all departments had access to the remote stroke unit, although the decisions of if/when to consult were at the discretion of the treating physician. All teleconferences were conducted by 4 senior neurologists. Immediately following a teleconsultation, both the stroke neurologist and the local physician completed a teleform.	Items to be completed included: reasons for no, immediate or delayed consolation, relevance of consolation (diagnostic work-up, CT assessment, ultrasound assessment and therapeutic procedures, rated on a 3-point scale) and ratings of the teleconference quality imaging/audio quality, rated on a 5-point scale, with 1=very good and 5=very bad).	153 (25%) patients received teleconsultation. Of these, 87 patients (57%) had an ischemic stroke, 9 (6%) had an ICH and 17 (11%) suffered a TIA. 25 patients (16%) had a diagnosis different from the primarily suspected stroke. Patients who were treated using teleconference were younger compared with those who were not (67.5 vs. 75.2 yrs., p=0.001). Average duration of the teleconference was 15 minutes. Teleconsultation took place within the first 3 hours after admission to the local hospital (n=35), within 6 hours (n=54) and > 24 hours (n=40). In the diagnostic workup category, ratings for relevant contributions ranged from 41% to 80% for the local physicians and from 37% to 79% for the neurologists. In the CT assessment category, ratings for relevant contributions ranged from 21% to 47% for the local physicians and from 6% to 48% for the neurologists.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					In the therapeutic decision category, ratings for relevant contributions ranged from 6% to 57% for the local physicians and from 4% to 69% for the neurologists. The mean imaging quality scores of patients and CTs were 1.9 and 2.1, respectively. The mean audio quality was rated as 2.6 and 2.4 by the local and stroke neurologists. Mean patients satisfaction rating with the experience was 1.5.

Feasibility of Prehospital Telestroke Systems

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Prehospital Assessment					
Smith et al. 2016 *(iTREAT)* **USA** **Prospective study**	NA	27 simulated ambulance runs in 2 states (California and Virginia)	Actors portrayed 4 scripted stroke scenarios in 2 settings (in hospital bed and remotely in telestroke-equipped ambulance) and were assessed by 2 neurologists who completed NIHSS	**Primary Outcome:** Reliability of NIHSS through remote assessment	Intraclass correlation coefficient for all simulations combined was 0.96, 95% CI 0.92-0.98.
Van Hooff et al. 2013 **Belgium** **Feasibility study**	NA	NA	Technical feasibility and reliability of the Unassisted TeleStroke Scale (UTSS), a 16-item stroke severity scale designed to be administered by telestroke systems, was assessed using 2 trained healthy	**Primary Outcome:** Correlation between NIHSS and UTSS scores	Telestroke assessment was feasible in all scenarios with minor technical difficulties reported in 12 cases. The mean time to administer the UTSS was 3.1 minutes. There was a strong correlation between the UTSS and NIHSS scores (Spearman p=0.90, p<0.001). The intraclass correlation coefficient for single

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			volunteers, simulating 41 stroke syndromes during transport to hospital. Communication between a remote expert and 2 ambulances was established using an ambulance equipped with a telestroke system and a 4th generation mobile network.		measures was 0.98, p<0.001. There was excellent agreement between raters for 12 items, and moderate agreement for 3 items.
Mobile Stroke Units					
Itrat et al. 2016 **USA** **Prospective study**	NA	A mobile stroke team unit (MSTU) was established in 2014 to service the area of Cleveland. The team consists of a RN, paramedic, emergency medical technician and CT technologist. The ambulance is equipped with a CT and the ability to perform point-of-care blood tests, the results of which are transmitted remotely. NIHSS testing is also performed remotely by a vascular neurologist. If t-PA is indicated, it is initiated by the MSTU and the patient is transferred to a hospital, based on several factors (patient preference, stroke type and severity. Patients	The outcomes of the first 100 patients treated by the MSUT were compared with those who were treated in the ED for whom a stroke alert had been activated within 30 minutes of arrival during a one-year period (n=56).	**Primary outcome:** Process indicators	93 consults were completed without transmission interruption. Median duration of the video login was 20 minutes. Of the 100 evaluations that were performed by the MSUT, there were 30 cases of possible ischemic stroke. 16 patients received t-PA. The median time from door to CT completion was significantly shorter for the MSTU (13 vs. 18 min, p=0.003). Median time to CT read was the same in both groups (25 vs. 25 min, p=0.59). Median time from door to t-PA was significantly shorter for MSTU patients (32 vs. 58 min, p<0.001)

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
		with severe stroke, who are potential candidates for endovascular therapy are transported to one of 3 stroke centres.			
Belt et al. 2016 **USA** **Retrospective study**	NA	89 patients with suspected stroke, who arrived to the ED by an advanced life-support ambulance and who were received an in-transit neurology assessed, conducted by a specially-trained paramedic, in consolation with a hospital-based neurologist through a mobile telestroke system. 71 patients who had been treated with t-PA who had been brought to the ED from 2015-2016 by emergency medical transport	The process times were compared between the in-transit telestroke and non-telestroke groups.	**Primary outcome:** Door-to-needle time, Last-known-well-to-needle time	The teleconsult duration: For patients who received t-PA (n=15; 17%) mean duration was 7.3 minutes, 95% CI 4.9-9.8 minutes. For patients who did not receive t-PA (n=74) it was 4.7 minutes, 95% CI 3.9-5.4. Mean door-to- needle time was 13 minutes shorter with in-transit telestroke (28, minutes 95% CI: 23-35, vs. 41 minutes, 95% CI 36-47, p = 0.02). Mean last-known-well-to-needle time was 30 minutes less with in-transit telestroke (92 minutes, 95% CI 69-115 vs. 122 minutes, 95% CI 109-135)
Kunz et al. 2016 **Germany** **Retrospective study**	NA	Patients who were living independently prior to stroke, who received thrombolysis following acute stroke. Mean age was 70.5 years, 42% male, Median baseline NIHSS score was 8.	The outcomes of patients who received thrombolysis therapy using the mobile stroke unit, STEMO from 2011-2015 (n=305) were compared with patients who received thrombolysis but arrived to hospital via EMS (n=353). Patients from the EMS group were only included if they	**Primary outcome:** Excellent functional outcome at 3 months (mRS 0-1) **Secondary outcomes:** Proportion of patients living without severe disability, or able to ambulate independently (mRS 0-3) at 3 months, 3-month mortality	The median time from stroke onset to thrombolysis was significantly shorter in the STEMO group (73 vs. 115 minutes, p<0.0005. A significantly higher proportion of patients in the STEMO group were treated ≤ 90 minutes of stroke (62% vs. 35%, p<0.0005). There was no significant difference in the number of patients who achieved an excellent outcome at 3 months (53% STEMO vs. 47% conventional, p=0.14). A significantly higher proportion of patients in the

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			were treated during the hours that STEMO operated (0700-2300 h)	**Safety outcomes:** Intracranial hemorrhage, 7-day mortality	STEMO group were living without severe disability at 3 months (83% vs. 74%, p=0.004). 3-month mortality was significantly lower in the STEMO group (6% vs. 10%, p=0.022). There were no significant differences in the safety outcomes between the 2 groups (sICH 3% vs. 5%, p=0.27 and 7-day mortality 2% vs. 4%, p=0.23) Adjusting for baseline characteristics, STEMO was an independent predictor of living without severe disability at 3 months (OR=1.86, 95% CI 1.20-2.88, p=0.006), but was not an independent predictor of the primary outcome (OR=1.40, 95% CI 1.00-1.97, p=0.052).
Ebinger et al. 2014 ***PHANTOM-S* Germany** **Open-label RCT**	CA: ☒ Blinding patient: ☒ assessor: ☒ ITT: ☒	7,986 patients, who lived within 16 minutes' travel time from the fire station were STEMO was based, within symptom onset <4 hours. Treated at one of 14 hospitals. Mean age was 74 years, 44.5% were male.	Patients were randomized to receive response from a Stroke Emergency Mobile (STEMO) ambulance, equipped with a CT scanner, point-of-care-lab and a specialized pre-hospital stroke team including a paramedic, neurologist and neuroradiologist or to routine care (n=2,969) on alternating weeks.	**Primary outcome:** Time from alarm to t-PA treatment **Secondary outcomes:** Thrombolysis rate, in-hospital mortality, symptomatic ICH, adverse events	Of 3,213 patients who suffered a stroke during an on-STEMO week, STEMO was deployed in 1804 cases. In most of the cases when STEMO was not deployed, it was already in use and was not available. Of the patients with ischemic stroke, t-PA was used in 32.6% of STEMO deployment cases, 29% during STEMO weeks, and 21.1% during control weeks. Mean alarm to treatment time was significantly shorter in the STEMO deployed group compared with the control weeks (51.8 vs. 76.3 min, p<0.001). The proportions of patients treated with t-PA within 90 minutes of stroke were significantly higher when STEMO was deployed (58%), compared with 48% during STEMO weeks (i.e., STEMO not deployed) and 37% during control weeks. There were no significant differences among groups in hospital mortality, sICH or LOS.
Walter et al. 2012	CA: ☑ Blinding patient: ☒ assessor: ☒	100 patients 18-80 years with ≥1 stroke symptoms using the modified ROSIER criteria, beginning within	Patients were randomized to a mobile stroke unit (MSU) group (n=53) or a control group (n=47).	**Primary outcome:** Time from alarm to treatment decision **Secondary outcomes:**	The trial was stopped early after interim analysis, which demonstrated pre-specified superiority of the MSU. 200 patients were planned. 29 MSU patients (55%) and 25 (53%) control patients

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Germany **RCT**	ITT: ☑	the previous 2-5 hours. Median age was 71 years, 62% were male. Median baseline NIHSS scores were 5 (MSU) and 6 (control)	The MSU response consisted of a paramedic, neurologist and neuroradiologist and the ambulance was equipped with a portable CT scanner, a telemedicine system and a point-of-care laboratory. Patients in the control group received optimised conventional stroke management in hospital, which included point-of-care laboratory	Number of patients treated with t-PA, time from alarm to t-PA, number of patients with t-PA or intra-arterial recanalization, time from alarm to t-PA or to intra-arterial recanalization. NIHSS, BI and mRS scores at days 1 and 7.	were diagnosed with ischemic stroke. Median time from alarm to treatment decision was significantly shorter in the MSU group (35 vs. 76 min, p<0.0001). Median time from stroke onset to treatment decision was significantly shorter in the MSU group (56 vs. 104 min, p<0.0001). Similar proportions of patients were treated with t-PA (23% vs. 17%, p=0.30). Median times from alarm and symptom onset to treatment with t-PA were significantly shorter in the MSU group (38 vs. 73 min, p<0.0001, and 73 vs. 153, p=0.0011, respectively). 23% of patients in both groups were treated with t-PA or endovascular therapy. Median times from alarm and symptom onset to therapy were significantly shorter in the MSU group. There were no significant differences in neurological outcomes between groups, assessed using NIHSS, BI or mRS at either days 1 or 7. Survival at day 7 was 89% (MSU) and 96% (control). CT scanning was unavailable for 8 patients in the MSU group due to technical problems.

Efficacy of Telestroke Systems

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Chowdhury et al. 2012 **UK** **Controlled study**	CA: ☒ Blinding: patient ☒ assessor ☒ ITT: ☒	97 patients who received tPA following confirmed diagnosis of an ischemic stroke, treated within 3 hours of symptom onset.	Comparison of outcomes of patients treated at a single centre with specialized stroke expertise during regular business hours (Mon-Fri 0900-1700 hrs) (n=52) vs. patients treated outside of regular hours using telemedicine (n=45)	**Primary Outcomes:** Symptomatic ICH within 24-36 hours following treatment, 3-month mortality, proportion of patients with good outcome (mRS≤2) and poor outcome, (mRS3-6) at 3 months.	The only significant baseline difference between groups was a higher number of patients who were current smokers in the telemedicine group (31% vs. 13%, p=0.03). There were no significant differences between groups on any of the outcomes assessed (face-to-face vs. telemedicine groups) ICH: 7.7% vs. 4.4%, p=0.7 3-month mortality: 15.5% vs. 11%, p=0.6. Favourable outcome: 36.5% vs. 42%, p=0.9 Median stroke onset to treatment and admission to treatment times were significantly longer for patients in the telemedicine group (125 vs. 100 min, p=0.001 and 61 vs. 33 min, p<0.001, respectively.
Audebert et al. 2009 **Germany *TEMPis*** **Controlled study**	CA: ☒ Blinding patient: ☒ assessor: ☒ ITT: ☑	3,060 acute stroke patients admitted to hospital within 3 days of stroke onset. Patients living in intuitions at the time of stroke or whose residential status was unknown were excluded.	The outcomes of patients from 5 community hospitals with telemedicine access from 2 stroke centres (intervention group, n=1,938) were compared with those from 5 control hospital without specialized stroke services or access to telemedicine (n=1,122)	**Primary Outcomes:** Combined outcomes of death/need for institutionalization and death/dependency, (mRS>3 or Barthel Index score <60) assessed at 12 and 30 months	At 12 months, significantly fewer patients in the intervention group were dead or in an institution (32.1% vs. 35.8%, p=0.038). After adjustment, the difference was no longer significant (OR=0.89, 95% CI 0.75-1.07, p=0.223). At 30 months, there was no difference in the proportion of patients who were dead or institutionalized (42% vs. 45.1%, p=0.094). (Adjusted OR=0.93, 95% CI 0.78-1.11, p=0.40). At 12 months, significantly fewer patients in the intervention group were dead or dependent (46.1% vs. 55.5%, p<0.001, adjusted OR=0.65, 95% CI 0.54-0.78, p<0.001). At 30 months, significantly fewer patients in the intervention group were dead or dependent (53.3% vs. 58.4%, p=0.006, adjusted OR=0.82, 95% CI 0.68-0.98, p=0.031).
Audebert et al. 2006 **Germany *TEMPiS*** **Controlled study**	CA: ☒ Blinding patient: ☒ assessor: ☒ ITT: ☒	6,610 acute stroke patients from 12 regional hospitals and 2 stroke centres	Comparison of outcomes between patients admitted to regional (n=4,727) and stroke centres (n=1,883), a portion of whom received tPA. Data was collected prospectively over 1 year.	**Primary Outcomes:** Vital status at 7 days, ICH within 36 hours of treatment	Of the 2,603 patients presenting to one of the regional hospitals with an ischemic stroke, 115 (4.4%) were treated with tPA. Of the 1,286 patients presenting to a stroke centre with ischemic stroke, a significantly higher number 110 (8.8%) were treated with tPA (p<0.01). The baseline characteristics of patients treated at the 2 types of institutions were similar, with a few exceptions: more patients in the stroke centres had hyperlipidemia (44.5% vs. 23%) and atrial fibrillation (40.9% vs. 20.9%) and higher mean systolic BPs (123 vs. 116mm Hg).

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			In the regional hospitals, neurology services were provided by internal medicine (n=10) and neurology departments (n=2). Consultations for thrombolysis were conducted using videoconferencing.		There were no differences between regional and stroke centres for the outcomes of: Symptomatic hemorrhages: 7.8% vs. 2.7%, p=0.14 Mortality within 7 days: 3.5% vs. 0.9%, p=0.37 In-hospital mortality: 3.5% vs. 4.5%, p=0.74 Mean time from stroke onset to hospital admission was significantly longer for patients in the stroke centres (74 vs. 64 min, p<0.01) Mean time from admission to treatment was significantly longer for patients treated in regional hospitals (68 vs. 61 min, p=0.003) There was no difference in the mean time from stroke onset to treatment between groups (134 vs. 135 min, p=0.81)

Efficacy of Telestroke for Treatment with Thrombolysis

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Sanders et al. 2016 **USA** **Retrospective study**	NA	Patients treated with t-PA in 4 states. Median NIHSS score was 8. Median age was 62 years, 54% male.	The outcomes of 165 patients (2012-2014) who were treated with t-PA using the AcuteCare Telemedicine system that included 20 hospitals were compared to those of 65 patients who were also treated with t-PA using the same telemedicine system from 2010-2012 when there were only 7 participating	**Primary outcomes:** Door-to-needle (DTN) time for tPA administration, call-to-needle (CTN) time, and final diagnosis **Secondary outcomes:** door-to-call (DTC) time, onset-to-needle (OTN) time, and call-to-response (CTR) time	The median DTN time in the later cohort was significantly shorter (74.5 vs. 93 minutes, p<0.01). (Data were missing for 13.9% of patients) The median CTN time in the later cohort was significantly shorter (41 vs. 56 minutes, p<0.01). Data were excluded for 2.4% of patients The median DTC time in the later cohort was significantly shorter (31 vs. 38 minutes, p<0.01). Data were excluded for 21.1% of patients). The median CTR time was similar between groups (1 vs. 2 minutes, p=0.098. The mean OTN was 179.4 minutes for patients in the earlier cohort vs. 149 minutes in the later cohort.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			hospitals.		
Mazighi et al. 2015 **France** **RCT** **TRUST-tPA**	CA: ☑ Blinding patient: ☒ assessor: ☑ ITT: ☑	49 patients ≥18 years with ischemic stroke, eligible for treatment with t-PA, admitted to one of 10 EDs without stroke units, from 2006-2010.	Using the telestroke network, all patients were assessed remotely for t-PA eligibility. If the patient was eligible, they were randomly assigned to usual care (n=23) or tele-thrombolysis (n=26) groups. Patients in the telethrombolysis group were treated with t-PA remotely and then transferred to the hub hospital with a stroke unit. Patients in the usual care group were transferred and then treated at the stroke centre.	**Primary outcome:** Excellent outcome (mRS of 0-1 at 90 days) **Secondary outcome:** Favourable outcome (mRS 0-2 at 90 days), early neurological improvement (NIHSS 0-1 at 24 hours or improvement of ≥4 points), all-cause mortality and any ICH or symptomatic ICH	The trial was stopped prematurely. Mean age of patients in the telethrombolysis group was significantly older (80 vs. 71 years, p=0.032), and the baseline NIHSS score was significantly lower (13 vs. 7, p=0.008). 21 telethrombolysis and 4 usual care patients were treated with t-PA. The most common reason for failure to treat hub patients was a delay between symptom onset and assessment at the stroke unit within 3 hours. The median duration of the video-conference longer in the telestroke group (73 vs. 23 minutes) A significantly higher number of patients in the usual care group had an excellent or favourable outcome (50.0% vs. 16.0%, p=0.013 and 59.1% vs. 28.0%, p=0.032, respectively). There were no significant differences between groups for the outcomes of death within 90 days (telestroke 24.0% vs. usual care 4.6%, p=0.10), any ICH (telestroke 28% vs. usual care 13.6%, p=0.30) or sICH telestroke 4.0% vs usual care 0%)
Zhai et al. 2015 **China** **Systematic review & meta-analysis**	NA	8 studies-RCTs, (n=0), prospective (n=5), or retrospective (n=3) observational with two-arm designs that examined the use of a telestroke system for delivery of thrombolytic agents. The number of subjects in each study ranged from 45-2,935. Mean	Studies that compared the outcomes of patients treated with t-PA through telemedicine vs. traditional in-hospital care	**Primary outcome:** Favourable outcome (using mRS, not defined) **Secondary outcomes:** ICH and mortality	Mean or median time between stroke onset and treatment ranged from 113-188 (telemedicine) and 100-157 minutes (in-hospital). There was no significant increase in the odds of a favourable outcome associated with telestroke (OR=1.28, 95% CI 0.92-1.76, p=0.14). Results from 5 studies included. There was no increased risk of symptomatic ICH associated with telestroke (OR=1.08, 95% CI 0.47-2.5, p=0.85). Results from 5 studies included. There was no increased risk of mortality associated with telestroke (OR=0.95, 95% CI 0.82-1.11, p=0.51). Results from 4 studies included.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
		baseline NIHSS scores ranged from 10-19			
Fong et al. 2015 **China** **Retrospective study**	NA	152 patients admitted to a single centre from 2009-2012 with acute ischemic stroke. Mean age was 66 years, 60% male. Median baseline MIHSS score was 12.	The outcomes of patients who had been treated with thrombolysis onsite (n=102) were compared with those of patients who received the same therapy via telemedicine (telephone consult + teleradiology (n=50)	**Primary outcome:** mRS score at 3 months, symptomatic ICH (extravascular blood in the brain associated with an increase of ≥4 points of NIHSS, or death)	Median onset-to-door time was significantly shorter for patients in the telestroke group (44 vs. 54 min, p=0.015). Median CT-to-needle time, door-to-needle time and onset- to -needle time were all significantly longer in the telemedicine group. The rate of sICH was similar between groups (4.9% vs. 4.0%, p=1.00) 3-month mortality was similar between groups (12% vs. 8.3%, p=0.58). The number of patients who experienced a good outcome (mRS 0-1) was similar between groups (43.0% vs. 52.1%, p=0.30)
Johansson et al. 2011 **Austria *Telestroke System in Salzburg (TESSA*)** **Controlled study**	NA	351 patients ≥18 years treated between 2006-2009 with tPA within 4.5 hours of symptom onset.	Comparison of outcomes of patients treated with telemedicine via videoconference at 5 regional hospitals (n=47) vs. those treated on a stroke unit (n=304). Following thrombolysis, patients at the regional hospital were transferred to the stroke unit for ongoing care.	**Primary Outcomes:** Mortality, discharge destination, stroke onset to needle time, proportion of patients with good functional outcome at 3 months (mRS≤1)	The only significant baseline difference between groups was a higher number of patients who were current smokers in the telemedicine group (32% vs. 16%, p=0.032). Mean NIHSS scores were similar between groups (9.9 vs. 10.4, p=0.73). There was no difference in the proportion of patient discharged home from hospital (31% vs. 26%, p=0.48). At 3 months, there was no difference in the proportion of patients with good outcome (47% telemedicine vs. 32% stroke unit, p=0.69), mortality (19% vs. 13%, p=0.25), or proportion of patients living at home (80% vs. 90%, p>0.05). Stroke onset to needle time was 113 min (telestroke) vs. 122 min (stroke unit), p=0.26.
Zaidi et al. 2011 **USA** **Controlled**	NA	A university-affiliated hospital (hub) that provided consultations to 12 spoke hospitals.	Comparisons of the outcomes of patients treated by the same neurologists, either in person, at the	**Primary Outcomes:** Onset to treatment time, door-to-needle time, proportion of patients with	There was no difference in the mean time from stroke onset to treatment between groups: 157 (stroke centre) vs. 145 min (telestroke), p=0.09. The mean time from arrival at hospital to treatment was shorter

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
study		142 acute stroke patients who received treatment with tPA	stroke center (n=59) or by telestroke, using videoconferencing (n=83) at a community hospital.	favourbale outcome at 3 months (mRS ≤2), mortality, symptomatic/asymptomatic ICH at 3 months	for patients in the stroke centre group (68 vs. 90 min, p<0.01). There were no significant differences in clinical outcomes between groups (stroke centre vs. telestroke) Percentage of patients with mRS ≤2: 22% vs. 35%, p=0.09 Mortality:37.5% vs. 42.1%, p=0.60 Asymptomatic ICH: 18.6% vs. 16.2%, p=0.70 Symptomatic ICH: 5.1% vs. 1.2%, p=0.10
Sairanen et al. 2011 **Finland** **Controlled study**	NA	5 community hospitals, served by the Helsinki University Central Hospital (HUCH), the hub hospital. Spoke hospital all had stroke units and thrombolysis treatment available during regular working hours. 106 patients considered eligible candidates for thrombolysis treatment.	Comparison of patients treated with tPA by telestroke (n=61) over 2 years compared with those treated at a stroke centre (n=985). Most patients who received telestroke services remained at the spoke facilities where they continued to receive care	**Primary Outcome:** Time to treatment, ICH within first 10 days, 3-month mortality, proportion of patients with mRS scores ≤1 and ≤2.	There were no differences in any of the clinical outcomes between groups (telestroke vs. stroke centre) 3-month mortality: 11.5% vs. 10.2%, p=0.662 Patients with mRS≤2: 49.1% vs. 58.1%, p=0.214 Patients with mRS≤1: 29.4% vs. 36.8%, p=0.289 ICH:6.7% vs. 9.4%, p=0.427 The mean onset to treatment time for telestroke patients was 120 min.
Pervez et al. 2010 **U.S.** **Controlled study**	NA	33 spoke hospitals (12 were connected via videoconferencing and 21 through phone connection) to a regional stroke centre 296 patients who received tPA within 3 hours of stroke onset and were subsequently	The outcomes of patients that arrived at the regional stroke center and those who were treated by telephone/telemedicine, were compared.	**Primary Outcome:** Symptomatic intracranial hemorrhages (sICH), mRS assessed at 3, 6 and 12 months and death.	Treatment with tPA was initiated in 181 (16.1%) cases at the spoke hospitals and in 115 (38.9%) at the RSC. sICH: There were no significant differences in number of sICHs between patients treated at the spoke hospitals and RSC (3.9% vs. 5.2%, p=0.58). There were no significant differences in distributions of patients in each mRS category between the spoke hospitals and RSC groups at each of the time points. Adjusted for age, time to tPA and NIHSS score, there were no significant differences in the odds of having a lower mRS score between patients whose tPA was initiated in an OSH vs. RSC (OR=1.09; 95% CI 0.77 to 1.55; p=0.64).

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
		transferred to the regional stroke centre (RSC).			There were no significant differences in in-hospital mortality rates between patients receiving tPA (14.9% vs. 17.45, p=0.57).
Switzer et al. 2009 **USA** **Controlled study** ***Remote Evaluation of Acute isChemic Stroke (REACH)***	NA	The telestroke REACH system connects a neurologist at a comprehensive stroke centre with 9 spoke hospitals, located in rural Georgia through a videoconferencing system. REACH was developed to support decision making for tPA. Patients treated with tPA were transferred to the tertiary centre. 50 patients were eligible for and received tPA treatment through REACH. 26 patients were treated with tPA at the hub centre.	Outcomes were compared between patients who received tPA administration remotely using the telestroke system and patients who receive tPA at the central tertiary care hospital.	**Primary Outcome:** Onset to treatment time and complications (symptomatic hemorrhagic conversion (sICH)) sICH assessed via. CT scan at 24 hours.	There were no significant differences in the mean onset to treatment times for patients receiving tPA at the tertiary care centre vs. patients receiving tPA remotely (146 vs. 128 min, p=0.0651). 35% and 50% of the patients at the hub and spoke centres were treated with tPA within 120 minutes, respectively There were no significant differences in the percentage of patients experiencing a sICH between the two groups (0 vs. 2, p=1.00).
Schwab et al. 2007 **Germany** **Observational Study**	NA	170 patients who received tPA following telestroke consultation and 132 consecutive patients who had been treated in one of the	Comparison of the outcomes between the two groups of patients	**Primary outcomes:** Mortality, good functional outcomes (defined as a Barthel Index score ≥95 or mRS score ≥1).	Mean time from stroke onset to administration of tPA: 141 min (community hospitals); 144 min (stroke centre). There were no statistically significant differences in deaths between the groups at both 3 months (11.2% vs. 11.5%, OR= 1.0; 95% CI 0.7-1.4; p=0.550) or 6 months (14.2%, vs. 13%, OR= 0.9; 95% CI 0.5-1.8; p=0.448).

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
TEMPiS (Telemedic Pilot Project for Integrative Stroke Care):		two stroke centres and received tPA over the same time period.		.	There were no statistically significant between-group differences in the proportion of patients who experienced a good outcome using BI criteria at either 3 months (45.1% vs. 40.1%, OR= 1.3; 95% CI 0.8-2.1; p=0.197) or 6 months (47.1% vs. 44.8%, OR= 1.1; 95% CI 0.6-1.8; p=0.443). There were no statistically significant between-group differences in the proportion of patients who experienced a good outcome using mRS criteria: at either 3 months (38.2% vs. 33.7%, OR= 1.2; 95% CI 0.7-2.0; p=0.258) or 6 months (39.5% vs. 30.9%, OR= 1.5; 95% CI 0.9-2.4; p=0.095). Age and baseline NIHSS score were the most significant predictors of good functional outcome. Group assignment (telemedicine vs. stroke centre) was not a significant predictor.
Frey et al. 2005 **USA** **Controlled study**	NA	126 acute stroke patients, who were neurologically intact prior to stroke, treated over a 4-year period.	Comparison of outcomes of patients treated at 43 community hospitals, which used telephone consultations to facilitate tPA administration with subsequent transport to the stroke centre (n=53) and patients treated in-house at the same stroke centre (n=73)	Increase in tPA usage in community hospitals, discharge destination, mortality, and time from stroke event to tPA administration.	The number of patients treated in community hospitals increased by 72% over the study period. Patients in the telephone consultation group were older (mean: 67 vs. 62 years, p=0.04). Stroke severity was lower in the in-house treated group (data not provided). Mean stroke onset to t-PA treatment times were similar in both groups (~160 minutes). Brain hemorrhages were low for patients in both groups (data not provided) Significantly more patients in the in-house group were discharge home (41 vs. 16, p=0.004). Significantly more patients in the telephone consultation group were transferred to a skilled nursing facility after discharge (11 vs. 3, p=0.003). 4 patients in the telephone group died during hospitalization vs. 1 patient in the in-house group (p=0.08).

Drip & Ship vs. Drip & Stay Models

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Heffner et al. 2015 **USA** **Retrospective study**	NA	272 patients with acute ischemic stroke treated at a single centre from 2006-2014, with t-PA	The outcomes of patients who were treated with t-PA via telemedicine at 5 spoke hospitals and remained for treatment (drip and stay, n=134) were compared with those who received treatment with t-PA at a spoke hospital and were then transferred to the hub hospital (n=73, drip and ship) to those that were treated at the hub hospital (n=272)	**Primary outcome:** Demographics, distribution of mRS scores at 90 days, complication rates	The mean drip and stay age of patients was significantly higher compared with the other 2 models (76.2 years vs. 72.1 and 70.7 years, p=0.013). The mean baseline NIHSS score was significantly lower in the drip and stay model (9.5 vs. 12.7 and 11.9, p<0.001). Mean onset-to-needle, door-to-needle times and symptomatic ICH were similar among groups. In multivariable analysis, the drip and stay patients had higher odds of in-hospital mortality (OR=6.8, 95% CI 2.2-21.7) and hospital LOS > 6 days (OR=4.3, 95% CI 2.4-7.8) compared with hub, and drip and ship patients. The odds of long-term survival (2,500 days) were significantly higher in the combined drip and ship and hub groups, compared with the drip and stay group (p<0.001)
Yaghi et al. 2015 **USA** **Retrospective study**	NA	204 patients admitted to a statewide stroke network from 2008-2012. Mean age was 67.5 years, 58% were male	The outcomes of patients treated in 31 spoke hospitals (n=44) with t-PA were compared to those treated in 2 hub hospitals (n=160). Patients were further stratified into two groups based on baseline NIHSS scores: NIHSS score of ≥8 (spoke n=25) and hub, n=109).	**Primary outcome:** mRS scores and mortality at 3 months post stroke	The number of patients with symptomatic ICH was 25 in both groups. There was no significant difference between groups in the number of patients who experienced a poor outcome (hub 39% vs. spoke 45%, p=0.48). Mortality was similar between groups (16% vs. 16%, p=1.00) In sub group analysis, patients with NIHSS scores ≥8 in the spoke group were significantly more likely to experience a poor outcome (76% vs. 50%, p=0.026). Mortality was similar between groups (spoke 24% vs. hub 22%, p=0.830).

Effectiveness of Telemedicine vs. Telephone Consultation for Stroke

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Meyer et al. 2012 **USA** ***STRokE DOC-Long-Term Outcome (LTO)*** **RCT**	CA: ☑ Blinding patient: ☒ assessor: ☑ ITT: ☒	75 subjects or surrogates of subjects who had participated in the STRokE DOC trial	6 & 12 months outcomes of subjects participating in the STRokE DOC trials were evaluated using a standardized questionnaire (n=37 telemedicine, n=38 telephone) administered over the telephone. Missing values for mortality outcomes were imputed.	**Primary outcome:** Mortality and proportion of patients with mRS scores ≤1 at 6 months **Secondary outcome:** Mortality and proportion of patients with mRS scores ≤1 at 12 months, recurrent stroke	Of the 222 patients who were recruited initially, 35 had died within 3 months. Mean time from enrollment was 3.96 years There were no differences in 6- month outcomes between groups (telephone vs. telemedicine) mRS score 0-1: 50% vs. 34%, p=0.23 Mortality: 15% vs. 21%, p=0.38 Recurrent stroke :4% vs. 6%, p=0.61 There were no differences in 12-month outcomes between groups (telephone vs. telemedicine) mRS score 0-1: 18% vs. 13%, p=0.23 Mortality: 17% vs. 25%, p=0.19 For subset of patients who received tPA 44% and 27% of subjects in the telephone and telemedicine groups had mRS scores of 1-2 at 6 months, (p=0.64) respectively.
Meyer et al. 2008 **USA** ***Stroke Team Remote Evaluation using a Digital Observation Camera (STRokE DOC)*** **RCT**	CA: ☑ Blinding patient: ☒ assessor: ☑ ITT: ☒	222 patients ≥18 years presenting with symptoms of acute stroke.	Patients were randomized to receive telemedicine (n=111), using real-time, 2-way audio/video and DICOM viewer or telephone (n=111) consultations to assess the patient's candidacy for tPA treatment. Consultations were provided by staff at a single hub institution to patients located at 4 remote sites.	**Primary outcome:** Correct treatment decision re: appropriateness for tPA evaluated by blinded, expert adjudication **Secondary outcomes:** Proportion of patients with good outcome at 90 days (mRS≤1, or Barthel Index score 95-100), mortality, ICH	There were no baseline differences between groups. Mean NIHSS scores were significantly higher in the telemedicine group (11.4 vs. 9.5, p=0.002). The number of patients treated with tPA was similar between groups (28% vs. 23%, p=0.425). Mean times from stroke onset to tPA were 157 and 143 min in the telemedicine and telephone groups, respectively (p=0.137). Correct treatment decisions were made more often using telemedicine (98% vs. 82%, OR=10.9, 95% CI 2.7-44.6, p=0.0009). There were no differences between groups (telemedicine vs. telephone) for any of the clinical outcomes

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					ICH: 7% vs. 8%, p=1.00 Good outcome: BI 95-100: 33% vs. 48%, p=0.287 mRS 0-1: 30% vs. 32%, p=1.00 Mortality: 39% vs. 12%, p=0.034 Mortality adjusted for baseline NIHSS: OR=3.4, 95% CI 0.6-19, p=0.168. Losses to follow-up: n=14 (7 from each group)
Demaerschalk et al. 2010 **USA** ***STRokE DOC Arizona Telestroke Trials*** **Pooled analysis**	NA	276 patients ≥18 years presenting with symptoms of acute stroke.	The results from the STRokE DOC trial were combined with those of a smaller unpublished study with an identical study protocol (STRoke DOC AZ) in which 54 patients were randomized to either a telemedicine group (n=27) or telephone consultation group (n=27). The results from the larger STRokE DOC trial suggested that telemedicine was superior while the results from the smaller trial failed to replicate this finding (no significant differences between treatment groups).	**Primary outcome:** Correct treatment decision re: appropriateness for tPA evaluated by blinded, expert adjudication **Secondary outcomes:** Proportion of patients with good outcome at 90 days (mRS≤1, or Barthel Index score 95-100), mortality, ICH	Mean NIHSS scores were significantly higher in the telemedicine group (10.6 vs. 7.7, p=0.006). The number of patients treated with tPA was similar between groups (29% telemedicine vs. 24% telephone, p=0.41). Mean times from stroke onset to tPA were 158 and 150 min in the telemedicine and telephone groups, respectively (p=0.137). Correct treatment decisions were made more often using telemedicine (96% vs. 83%, OR=4.2, 95% CI 1.69-10.46, p=0.002). There were no differences between groups (telemedicine vs. telephone) for any of the clinical outcomes ICH: 8% vs. 6%, p=1.00 BI: 95-100: 46% vs. 55%, p=0.17 mRS 0-1: 36% vs. 45%, p=0.20 Mortality: 16% vs. 12%, p=0.49
Khan et al. 2010 **Canada** **Retrospective study**	NA	Consultations were provided over a 2-year period to 7 spoke hospital (4 using videoconferencing and 3 using telephone consultation) from a	Compared outcomes among those patients who were treated by telephone consultation and telemedicine.	**Primary outcome:** Favourable outcome (mRS 0-1) at three months, cost savings.	There was no significant difference in the mean time from stroke onset to tPA administration between the video consult and phone consults groups (171 vs. 179 minutes, p=0.76). There was no significant difference in the proportion of patients experiencing a favourable outcome at 3

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
		single university-affiliated hub hospital. None of the spoke hospitals had stroke units. 44 patients were eligible for and received tPA. 34 patients were treated using videoconferencing and 10 using telephone consultation.			months p=0.689). Cost savings: Patients who received tPA in the remote hospitals experienced a reduced length of stay in hospital compared to those patients that did not receive tPA. 1,015 days saved at $903/day results in an approximate $916,545 savings at one site. Loss to follow-up: 4 (9%) of patients.
Pervez et al. 2010 **U.S.** **Controlled study**	NA	33 spoke hospitals (12 were connected via videoconferencing and 21 through phone connection) to a regional stroke centre 296 patients who received tPA within 3 hours of stroke onset and were subsequently transferred to the regional stroke centre (RSC).	Compared outcomes among those patients who were treated by telephone consultation and telemedicine. (Comparison of hub and spoke outcomes is described above)	**Primary outcomes:** Symptomatic intracranial hemorrhages (sICH), mRS assessed at 3, 6 and 12 months and death.	There were no significant differences in number of sICH's between the video and telephone groups (4.8% vs. 3.1%, p=0.56). Adjusted for age, time to tPA and NIHSS score, there were no significant differences in the odds of having a lower mRS score between patients whose tPA was initiated via video or telephone (OR 0.79; 95% CI 0.49 to 1.29; p=0.35). In-hospital mortality was significantly lower for those patients over 80 years of age in the video conferencing group compared to the telephone group (p=0.05).
Handschu et al. 2008 **Germany** **Controlled study** ***Stroke Care using Telemedicine in Northern Bavaria (STENO)***	NA	151 patients admitted to local hospitals with symptoms of acute stroke	Comparison of outcomes of patients treated by telemedicine (n=77) or telephone (n=74) consultation provided by 2 stroke centres to 2 local hospitals. Consulting sites alternately weekly between telephone and telemedicine consultation types. (No info on tPA	**Primary outcomes:** 10-day mortality, need for institutional care	Number of patients identified with ischemic stroke was 91(60%). Fewer patients in the telemedicine group were transferred to a stroke centres (9.1% vs. 14.9%, p<0.05). Mortality was higher in patients in the telephone group (6.8% vs. 1.3%, p<0.05). Diagnoses made based on telephone consultation needed to be corrected more frequently (17.6% vs. 7.1%, p<0.02).

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			administration was provided)		5.4% of patients in the telephone group required institutional care compared with 2.6% of patients in the telemedicine group (p=0.58)

Cost-Effectiveness of Telemedicine

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Nelson et al. 2016 **USA** **Cost-effectiveness analysis**	NA	Patients who were admitted with acute ischemic stroke to one of the spoke hospitals in the Providence Oregon Telestroke Network (2 hub hospital and 17 spoke hospitals	Comparison of in-hospital costs prior to the implementation of the telestroke system (up to 2 years prior, n=98) and up to 3 years after the start date of the telestroke system (n=766). Actual reimbursement costs were used (not estimates). A decision analytic model was used to estimate probabilities of the consequences of treatment decisions at critical points (e.g. t-PA vs. no t-PA). Stroke severity, based on NIHSS scale was also included in the models.	**Primary outcomes:** Costs, incremental costs, Quality-adjusted life years (QALYs), incremental cost-effectiveness ratio (ICER), calculated from the perspective of both the spoke and hub perspectives	Mean hospital costs for patients who received t-PA were slightly higher for spoke vs. hub hospitals (US$19,928 vs. US$17,244). Mean hospital costs for patients who did not receive t-PA were higher at hub hospitals (US$17,133 vs. US$8538). **Spoke perspective** Depending on the percentage of implementation costs the spoke hospital assumed, the ICER was: 0%: $1,322/QALY 50% $25,991/QALY 100%: $50,687/QALY Telestroke dominated (lower cost, better outcome) for patients with less severe strokes (NIHSS <5) when hospitals assumed 50% and 100% of costs. **Hub perspective** Depending on the percentage of implementation costs the spoke hospital assumed, the ICER was: 0%: $71,703/QALY 50% $47,0333/QALY 100%: $22,363/QALY Telestroke dominated (lower cost, better outcome) for patients with less severe strokes (NIHSS <5) when hospitals assumed 0%, 50% and 100% of costs.
Switzer et al. 2013	NA	NA (theoretical model)	Using a decision analytic model, comparison of costs	**Primary outcome:** 5-year costs for hub/spoke hospitals.	The model predicted that 114 fewer ischemic stroke patients would present to the hub hospital each year, and 16 more patients would present to one of the spoke

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
USA **Cost-effectiveness analysis (hospital perspective)**			and outcomes associated with patients presenting with acute ischemic stroke to spoke hospitals with and without telestroke access Assumptions: an established telestroke system with 7 spokes hospital and a single hub hospital with 1,112 ischemic stroke patients presenting to the ER/yr. Costs, (telestroke start-up, costs for spoke/hub and patient costs, patient transfer costs, long-term costs), event probabilities, (tPA vs. no tPA, endovascular treatment/no endovascular treatment) and discharge destinations, based on mRS scores) were based on 2 author's affiliated institutions actual costs.		hospitals. From the network perspective, there was an overall costs savings of $358,435 during the first 5 years. The model also predicted that 45 additional patients could be treated with tPA and 20 more could receive endovascular therapy if a telestroke system were in place. This would also result in an additional 6.1 patients being discharged home/yr. with an equal number of decreases in admissions to rehab and nursing homes. The hub hospital would incur costs of $405K/yr while the spoke hospitals would save $109K/yr. With cost sharing arrangements, the model predicted that each hospital could save $45K over 5 years. The model was sensitive to the number of spoke hospital, the number of transfers and the number of patients treated with endovascular therapy. Cost savings increased with increasing numbers of spoke hospitals. As transfer rates increased, costs savings to the networks decreased. Additional savings were predicted when endovascular therapy was reduced by 50% and 75%.
Nelson et al. 2011 **USA** **Cost-effectiveness analysis (societal perspective)**	NA	NA (theoretical model)	Using a decision analytic model, comparison of costs and outcomes associated with patients presenting with acute ischemic stroke to spoke hospitals with and without telestroke access	**Primary outcomes:** Costs, incremental costs, Quality-adjusted life years (QALYs), incremental cost-effectiveness ratio (ICER), associated with 90-day and lifetime horizons.	90-day costs for usual care and telestroke were $13,872 vs. $14,274 (incremental cost=$402). The respective QALYs were 0.119 and 0.123. ICER=$108,363/QALY Lifetime costs for usual care and telestroke were $130,343 vs. $133,527 (incremental cost=$3,184). The respective QALYs were 8.85 and 10.15. ICER=$3,449/QALY

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			Assumptions: an established telestroke system with 8 spokes hospital and a single hub hospital staffed with 4 neurologists, with telestroke capability from the hospital or physician's home. Costs, (telestroke infrastructure costs for spoke/hub and patient costs, patient transfer costs, long-term costs), event probabilities, (tPA vs. no tPA and discharge destinations, based on mRS scores) were estimated using the published literature.	Willingness to pay threshold was $50K/QALY	For start-up telestroke networks, the 90 day ICERs for hospitals with 1 and 3 spokes were $480,258/QALY and $196,910/QALY. For start-up telestroke networks, the lifetime ICERs for hospitals with 1 and 3 spokes were $3,509/QALY and $2,701/QALY. ICERS varied considerably in sensitivity analyses when input parameters (# patients /spoke and transfer costs) were varied. Monte Carlo simulations yielded ICERs of <$50K 99.7% and 37.5% of the time for lifetime and 90-day horizons, respectively.
Demaerschalk et al. 2010 **USA** **Systematic review**	NA	24 studies evaluating cost analysis of tPA, stroke centres and telemedicine There were no inclusion/exclusion criteria stated. Search terms included stroke, cost and telemedicine	Narrative reporting of the results from 6 studies that examined aspects of costs associated with telemedicine for stroke	**Primary outcome:** Incremental cost-effectiveness ratio, (ICER) cost savings	No cost-effectiveness articles were found. Most articles focused on the cost of implementation and/or operational costs associated with the systems, although the specific costs/savings ($) associated with telemedicine from any of the 6 studies included, were reported.

Telemedicine for Stroke Rehabilitation

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Chen et al. 2016 **China** **Systematic review & meta-analysis**	NA	7 RCTs that included patients ≥18 years who had sustained a stroke and received rehab therapies through telemedicine systems for a minimum of 4 weeks in duration. Mean ages of patients ranged from 53-75 years.	In 6 trials, virtual reality based training was used to provide rehab therapies, while therapies or support were provided by either the phone or the internet in 2 trials. The control group in most trials was usual or standard care.	**Primary outcome:** Measures of disability or ADL assessment **Secondary outcomes:** Motor function, cognitive assessments, health-related QoL	Using the results from 4 trials, there was no difference in mean Barthel Index scores between groups (SMD=-0.05, 95% CI -0.24-0.13, p=0.57). Using the results from 2 trials, there was no difference in mean Berg Balance Scale scores between groups (SMD=-0.17, 95% CI -0.70-0.37, p=0.54). Using the results from 2 trials, there was no difference in mean Fugl-Meyer (Upper Extremity) scores between groups (SMD=0.05, 95% CI -0.09-1.09, p=0.10).
Laver et al. 2013 **Australia** **Cochrane review**	NA	10 RCTs (n=860) including patients with all stroke types, including SAH at all levels of severity and at all stages stroke recovery. 2 trials recruited patients in the acute stage of stroke while the remainder recruited patients in the subacute and chronic stage.	Trials comparing telerehabilitation (services delivered using information and communication technologies) programs composed of ≥1 session, compared with in-person or no rehabilitation and trials comparing 2 different types of telerehabilitation. All interventions were delivered in patient's homes. 4 trials used customised computer-based training programmes and 4 delivered an exercise programme using technologies to enable communication between the participant and the teletherapist. Most interventions included at least 3	**Primary outcome:** Independence in ADL **Secondary outcome:** Upper-limb function, mobility, participant satisfaction, HR QoL, cognitive function, functional communication	There was no significant difference in the ability to perform ADLs between groups (SMD=0.0, 95% CI -0.15-0.15, p=0.990). The results from 2 trials included. There was no significant difference in upper-extremity performance between groups (MD Fugl Meyer Assessment=3.65, 95% CI -0.26-7.57, p=0.067). The results from 2 trials included. Pooled analyses for other outcomes were not possible.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			contacts with follow-up periods of at least 1 month		
Chumbler et al. 2012, 2015 **USA** ***Stroke Telerehabilitation (STeleR)*** **RCT**	CA: ☑ Blinding patient: ☒ assessor: ☑ ITT: ☒	52 veterans who had suffered a stroke within the previous 2 years, aged 45-90 years, living in the community, without cognitive impairment, and a discharge FIM score of 18-88 were included.	Patients were randomized to a STeleR group (n=25) or to a usual care group (n=23) The STeleR intervention focused on improvement of functional mobility. The program lasted 3 months, and included 3 components: 3x 1 hour televisits to the participant's home, 5 telephone calls and an in-home messaging device system to instruct patients on functional exercises and adaptive strategies. Patients in the usual care group could receive any services provided by VA or non-VA, at their discretion	**Primary outcome (2012):** Telephone Version of FIM (FONEFIM), overall function domain of the Late-Life Function and Disability Instrument (LLFDI) **Secondary outcome (2012):** Additional domains of the LLFDI **Primary outcomes (2015):** Falls Efficacy Scale (FES), Stroke-specific Patient Satisfaction with Care Scale (SSPSC)-9 items for hospital care, 4 items for home care Outcomes were assessed a baseline, 3 and 6 months	48 patients completed baseline assessments. **2012** Mean±sd scores for STeleR and usual care groups at baseline and 6 months were: FONEFIM (motor domain): 83.5±9.5 to 83.7±9.9 vs. 81.5±12.1 to 80.9±12.0, p=0.306 LLFDI (overall function total): 49.5±10.1 to 54.6±12.0 vs. 51.7±12.8 to 50.6±11.7, p=0.248 LLFDI (disability components): Personal role frequency: 47.6±10.8 to 49.6±18.1 vs. 49.2±14.8 to 47.2±11.9, p=0.025 Difficulty dimension total: 53.9±21.5 to 68.0±16.6 vs. 62.2±15.3 to 59.5±17.7, p=0.025 Instrumental role difficulty: 52.5±21.5 to 68.1±13.2 vs. 61.2±15.9 to 58.0±18.7, p=0.031. There were no significant differences between groups on any of the other LLFDI function domains (upper, lower or advance lower extremity scores), or the remaining disability components (frequency dimension total and social role frequency) **2015** There were no significant differences in mean baseline FES scores between groups or 6-month follow-up. The scores in both groups increased over time (2.2 vs. 2.3 points) There was a significant increase in the mean SSPSC score (hospital care) at 6 months between groups favouring the STeleR group (+4.5 vs. -3.2, p=0.029). There was no significant difference in mean SSPSC

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					score (home care) at 6 months between groups (+1.7 vs. -0.4, p=0.077). Drop outs and losses to follow-up: n=5
Taylor et al. 2009 **Canada** **Feasibility study**	NA	12 patients with stroke, which occurred on average 16 months previously + 4 caregivers. Patients living in long-term care, those still actively participating in a rehabilitation program and those with severe communication difficulties, were excluded.	A self-management program, Moving On after Stroke (MOST) delivered over 9 weeks, with (2 sessions/week, (2 hours/session) was delivered by 2 facilitators at an urban site to 7 participants and their families, also located at the same site and also, remotely, using videoconferencing to 5 participants and their caregivers, located at two remote locations.	**Primary outcomes:** Feasibility (assessed through attendance records, telehealth delivery, required adaptations and staff/participant/caregiver perceptions of the program) **Secondary outcomes:** Reintegration to Normal Living (RNL), Geriatric Depression Scale (GDS), Activity-Specific Balance Confidence Scale (ABC), berg Balance Scale (BBS) and 6-Minute Walk Test (6MWT) were assessed before and after the program and at 3-month follow-up	Average attendance for all participants was 83% (90% for local attendees and 70% for the remote group) 3 technical problems arose over 18 sessions (difficulties connecting remotely, which were resolved within 5 minutes) Participants in both groups reported satisfaction with the program From Baseline to follow-up, there were improvements in all outcomes (mean ±sd): RNL: 3.2±2.9 to 4.3±2.6, p=0.22 GDS: 5.3±3.2 to 3.2±2.3, p=0.04* ABC: 65.6±26.5 to 74.6±12.0, p=0.12 BBS: 48.5±8.5 to 50.2±3.2, p=0.66 6MWT (m): 280.2±96.9 to 251.4±72.3, p=0.02* * Missing values were imputed Drop outs: n=3 Adverse events: none
Piron et al. 2009 **Italy** **RCT**	CA: ☑ Blinding patient: ☒ assessor: ☑ ITT: ☒	36 subjects with mild to moderate arm motor impairment (Fugal Meyer Assessment (FMA) upper-extremity scores 30-55) following stroke, which occurred an average of 12 months previously. Subjects with cognitive impairment, neglect or communication deficits, were excluded	Patients were randomized to a Tele-rehab (n=18) or a control group (n=18) upper-limb therapy program Patients in the control group were treated with conventional physical therapy and asked to perform exercises progressing in difficulty. Patients in the Tele-	**Primary outcomes:** FMA (upper-extremity), Ashworth Scale (AS) scores. Assessments were conducted one month prior to randomization (T0), start of therapy (T1), end of therapy (T2) and at 1-month follow-up (T3).	Mean±sd FMA scores for patients in Telerehab and control groups were: T0: 48.3±7.2 vs. 47.3±4.5 T1:48.5±7.8 vs. 47.3±4.6 T2: 53.6±7.7 vs. 49.5±4.8, p<0.05 T3: 53.1±7.3 vs. 48.8±5.1 Mean±sd AS scores for patients in Telerehab and control groups were: T0: 2.2±1.6 vs. 1.3±1.0 T1:2.4±1.9 vs. 1.3±1.0 T2: 1.7±2.0 vs.1.0±0.8, p<0.05 T3: 2.0±2.0 vs. 1.1±0.9

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			rehab group performed 5 exercises using a PC-based virtual reality system. A therapist provided feedback remotely. The duration of the program for patients in both groups was 1 month (1 hour/day, 5x/week).		Drop-outs=0
Piron et al. 2008 **Italy** **RCT**	CA: ☒ Blinding patient: ☒ assessor: ☒ ITT: ☒	10 patients with mild/moderate arm motor impairment following ischemic stroke, occurring an average of 10 months previously, without cognitive impairment	Patients were randomized to a 1-month program (1 hour/day) of virtual reality (VR) therapy using telemedicine to participate from home (n=5), or to receive the same VR program in hospital (n=5)	**Primary outcome:** 12-item patient satisfaction questionnaire (5- point Likert Scale 1=strongly disagree, 5=strongly agree), Fugl-Meyer Assessment (upper-extremity portion)	Median patient satisfaction scores for VR vs. Tele-VR groups for each items were: 4 vs.5 4 vs.4 4 vs.4 4 vs.5 4 vs.5 4 vs.5 4 vs.4 4 vs.4 4 vs.3 4 vs.5 4 vs.5 4 vs.5 Mean FMA scores at baseline and end of treatment for patients in the TeleVR group and VR groups were: 51.2 to 56.6 ($p<0.05$) and 49.4 to 56.0 ($p<0.05$) Drop outs=0
Huijgen et al. 2008 **The Netherlands** **RCT**	CA: ☒ Blinding patient: ☒ assessor: ☒ ITT: ☒	81 subjects >18 years, with stroke (n=16), TBI or MS, with performance on 9-Hole Peg test (9HPT)>180 sec, who were living at home in stable clinical status. Patients with serious cognitive/behavioural/vi	Patients were randomized to an intervention group (n=55), consisting of 1 month of usual care, (general exercise program) followed by a 1-month program (30 min, 5 days/week) using the Home Care Activity Desk, using a portable	**Primary outcome:** Action Research Arm test (ARAT), 9HPT **Secondary outcome:** User satisfaction (100-point VAS) Outcomes were assessed at baseline, 1 month and 2 months	There were no significant differences between groups at any of the assessment points Mean (±sd) ARAT and 9HPT scores for stroke patients in the control group at T0, T1 and T2 were: 46.7±11.2, 44.3±15.1 and 47.3±40.9; 73.4±58.7, 61.0±45 and 61.0±48.4 2/9 vs. 1/9 stroke patients in the intervention and control groups reported clinically significant improvement (±5.7 ARAT points)

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
		sual/ communication/problems and medical complications, were excluded.	telemedicine system, to facilitate upper-limb rehabilitation, or to a control group (n=26) and received usual care for 2 months		Mean (±sd) ARAT and 9HPT scores for stroke patients in the intervention group at T0, T1 and T2 were: 40.7±12.6, 39.3±14.2 and 40.9±13.4 106.4±65.0, 85.5±57.6 and 88.5±54.3 Both patients and therapists were generally satisfied with 6 aspects of the program (acceptance, aesthetic aspect, ease of use, hardness of the task, suitability of the tasks, general opinion). 11 patients were lost to follow up.
Lai et al. 2004 **China** **Single group intervention study**	CA: ☒ Blinding patient: ☒ assessor: ☒ ITT: ☒	21 subjects, at least 6-month post stroke, who were able to walk independently, with/without aids. Exclusions included MMSE scores <18, aphasia and pulmonary insufficiency	8-week program (1 session/week, 1.5 hrs/session) conducted at a community centre for seniors, conducted by a physiotherapist via videoconference link. Intervention included education (secondary prevention, medical management, and safety), exercise to improve strength and balance (30 min), and community support	**Primary outcome:** Berg Balance Scale (BBS), State Self-Esteem Scale (SSES), SF-36, stroke knowledge test (10 items) Outcomes were assessed before and after intervention. A focus group was also conducted following the intervention to evaluate satisfaction with the program	19 patients completed the program Mean time post stroke was 3 years. Baseline and post intervention scores (mean±sd): BBS: 42.2±6.7 to 49.0±6.5, p<0.0001 SSES: 64.8±12.3 to 79.8±12.8, p<0.0001 There were significant improvements in all aspects of the SF-36 Knowledge tests: 4.8±1.7 to 8.7±1.5, p<0.0001 63% and 37% of subjects rated the clinical effectiveness of the program as good and excellent, respectively.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations

References

Agarwal S, Day DJ, Sibson L, Barry PJ, Collas D, Metcalf K et al. Thrombolysis delivery by a regional telestroke network--experience from the U.K. National Health Service. *J Am Heart Assoc 2014*; 3(1):e000408**.**

Audebert HJ, Kukla C, Clarmann von CS, et al. Telemedicine for safe and extended use of thrombolysis in stroke: the Telemedic Pilot Project for Integrative Stroke Care (TEMPiS) in Bavaria. *Stroke* 2005;36:287-91.

Audebert HJ, Kukla C, Vatankhah B, et al. Comparison of tissue plasminogen activator administration management between Telestroke Network hospitals and academic stroke centers: the Telemedical Pilot Project for Integrative Stroke Care in Bavaria/Germany. *Stroke* 2006;37:1822-27.

Audebert HJ, Schultes K, Tietz V, et al. Long-term effects of specialized stroke care with telemedicine support in community hospitals on behalf of the Telemedical Project for Integrative Stroke Care (TEMPiS). *Stroke* 2009;40:902-08.

Belt GH, Felberg RA, Rubin J, Halperin JJ. In-Transit Telemedicine Speeds Ischemic Stroke Treatment: Preliminary Results. *Stroke 2016*;47(9):2413-2415.

Chen J, Jin W, Zhang XX, Xu W, Liu XN, Ren CC. Telerehabilitation Approaches for Stroke Patients: Systematic Review and Meta-analysis of Randomized Controlled Trials. *J Stroke Cerebrovasc Dis 2015*;24(12):2660-8

Choi JY, Porche NA, Albright KC, et al. Using telemedicine to facilitate thrombolytic therapy for patients with acute stroke. *Jt Comm J Qual Patient Saf* 2006;32:199-205.

Chowdhury M, Birns J, Rudd A, et al. Telemedicine versus face-to-face evaluation in the delivery of thrombolysis for acute ischaemic stroke: a single centre experience. *Postgrad Med J* 2012;88:134-37.

Chumbler NR, Quigley P, Li X, et al. Effects of telerehabilitation on physical function and disability for stroke patients: a randomized, controlled trial. *Stroke* 2012;43:2168-74.

Chumbler NR, Li X, Quigley P, Morey MC, Rose D, Griffiths P et al. A randomized controlled trial on Stroke telerehabilitation: The effects on falls self-efficacy and satisfaction with care. *J Telemed Telecare 2015*;21(3):139-43.

Demaerschalk BM, Hwang HM, Leung G. Cost analysis review of stroke centers, telestroke, and rt-PA. *Am J Manag Care* 2010;16:537-44.

Demaerschalk BM, Raman R, Ernstrom K, et al. Efficacy of telemedicine for stroke: pooled analysis of the Stroke Team Remote Evaluation Using a Digital Observation Camera (STRokE DOC) and STRokE DOC Arizona telestroke trials. *Telemed J E Health* 2012;18:230-37.

Ebinger M, Winter B, Wendt M, Weber JE, Waldschmidt C, Rozanski M et al. Effect of the use of ambulance-based thrombolysis on time to thrombolysis in acute ischemic stroke: a randomized clinical trial. *JAMA* 2014; 311(16):1622-1631.

Fong WC, Ismail M, Lo JW, Li JT, Wong AH, Ng YW, et al. Telephone and Teleradiology-Guided Thrombolysis Can Achieve Similar Outcome as Thrombolysis by Neurologist On-site. *J Stroke Cerebrovasc Dis 2015*;24(6):1223-8.

Frey JL, Jahnke HK, Goslar PW, et al. tPA by telephone: extending the benefits of a comprehensive stroke center. *Neurol* 2005;64:154-56.

Hess DC, Wang S, Hamilton W, Lee S, Pardue C, Waller JL et al. REACH: clinical feasibility of a rural telestroke network. *Stroke 2005*; 36(9):2018-2020**.**

Handschu R, Scibor M, Willaczek B, et al. Telemedicine in acute stroke: remote video-examination compared to simple telephone consultation. *J Neurol* 2008;255:1792-97.

Heffner DL, Thirumala PD, Pokharna P, Chang YF, Wechsler L. Outcomes of Spoke-Retained Telestroke Patients Versus Hub-Treated Patients After Intravenous Thrombolysis: Telestroke Patient Outcomes After Thrombolysis. *Stroke 2015*;46(11):3161-7.

Huijgen BC, Vollenbroek-Hutten MM, Zampolini M, et al. Feasibility of a home-based telerehabilitation system compared to usual care: arm/hand function in patients with stroke, traumatic brain injury and multiple sclerosis. *J Telemed Telecare* 2008;14:249-56.

Itrat A, Taqui A, Cerejo R, Briggs F, Cho SM, Organek N, et al. Telemedicine in Prehospital Stroke Evaluation and Thrombolysis: Taking Stroke Treatment to the Doorstep. *JAMA Neurol 2016*;73(2):162-8.

Johansson T, Mutzenbach SJ, Ladurner G. Telemedicine in acute stroke care: the TESSA model. *J Telemed Telecare* 2011;17:268-72.

Khan K, Shuaib A, Whittaker T, et al. Telestroke in Northern Alberta: a two-year experience with remote hospitals. *Can J Neurol Sci* 2010;37:808-13.

Kunz A, Ebinger M, Geisler F, et al. Functional outcomes of pre-hospital thrombolysis in a mobile stroke treatment unit compared with conventional care: an observational registry study. *Lancet Neurol* 2016 15(10):1035-43.

Lai JC, Woo J, Hui E, et al. Telerehabilitation - a new model for community-based stroke rehabilitation. *J Telemed Telecare* 2004;10:199-205.

LaMonte MP, Bahouth MN, Hu P, et al. Telemedicine for acute stroke: triumphs and pitfalls. *Stroke* 2003;34:725-28.

Laver KE, Schoene D, Crotty M, George S, Lannin NA, Sherrington C. Telerehabilitation services for stroke. *Cochrane Database of Systematic Reviews* 2013, Issue 12. Art. No.: CD010255. DOI: 10.1002/14651858.CD010255.pub2.

Legris N, Hervieu-Begue M, Daubail B, Daumas A, Delpont B, Osseby GV, et al. Telemedicine for the acute management of stroke in Burgundy, France: an evaluation of effectiveness and safety. *Eur J Neurol 2016*;23:1433-1440.

Mazighi M, Meseguer E, Labreuche J, Miroux P, Le Gall C, Roy P, et al. TRUST-tPA trial: Telemedicine for remote collaboration with urgentists for stroke-tPA treatment. *J Telemed Telecare* 2016 ;23(1):174-180.

Meyer BC, Raman R, Hemmen T, et al. Efficacy of site-independent telemedicine in the STRokE DOC trial: a randomised, blinded, prospective study. *Lancet Neurol* 2008;7:787-95.

Meyer BC, Raman R, Ernstrom K, et al. Assessment of long-term outcomes for the STRokE DOC telemedicine trial. *J Stroke Cerebrovasc Dis* 2012;21:259-64.

Muller-Barna P, Hubert GJ, Boy S, Bogdahn U, Wiedmann S, Heuschmann PU et al. TeleStroke units serving as a model of care in rural areas: 10-year experience of the TeleMedical project for integrative stroke care. *Stroke 2014*; 45(9):2739-2744.

Nelson RE, Saltzman GM, Skalabrin EJ, et al. The cost-effectiveness of telestroke in the treatment of acute ischemic stroke. *Neurology* 2011;77:1590-98.

Nelson RE, Okon N, Lesko AC, Majersik JJ, Bhatt A, Baraban E. The cost-effectiveness of telestroke in the Pacific Northwest region of the USA. *J Telemed Telecare* 2015; 5(5):260-263.

Pedragosa A, Alvarez-Sabin J, Molina CA, et al. Impact of a telemedicine system on acute stroke care in a community hospital. *J Telemed Telecare* 2009;15:260-63.

Pervez MA, Silva G, Masrur S, et al. Remote supervision of IV-tPA for acute ischemic stroke by telemedicine or telephone before transfer to a regional stroke center is feasible and safe. *Stroke* 2010;41:e18-e24.

Piron L, Turolla A, Tonin P, et al. Satisfaction with care in post-stroke patients undergoing a telerehabilitation programme at home. *J Telemed Telecare* 2008;14:257-60.

Piron L, Turolla A, Agostini M, et al. Exercises for paretic upper limb after stroke: a combined virtual-reality and telemedicine approach. *J Rehabil Med* 2009;41:1016-102.

Sairanen T, Soinila S, Nikkanen M, et al. Two years of Finnish Telestroke: thrombolysis at spokes equal to that at the hub. *Neurol* 2011;76:1145-52.

Sanders KA, Patel R, Kiely JM, Gwynn MW, Johnston LH. Improving Telestroke Treatment Times in an Expanding Network of Hospitals. *J Stroke Cerebrovasc Dis.* 2016;25(2):288-291.

Schwab S, Vatankhah B, Kukla C, et al. Long-term outcome after thrombolysis in telemedical stroke care. *Neurol* 2007;69:898-903.

Schwamm LH, Rosenthal ES, Hirshberg A, et al. Virtual TeleStroke support for the emergency department evaluation of acute stroke. *Acad Emerg Med* 2004;11:1193-97.

Smith SNC, Govindarajan P, Padrick MM, et al. A low-cost, tablet-based option for prehospital neurologic assessment The iTREAT Study. Neurol 2016:87(1):19-26.

Switzer JA, Hall C, Gross H, et al. A web-based telestroke system facilitates rapid treatment of acute ischemic stroke patients in rural emergency departments. *J Emerg Med* 2009;36:12-18.

Switzer JA, Demaerschalk BM, Xie J, et al. Cost-effectiveness of hub-and-spoke telestroke networks for the management of acute ischemic stroke from the hospitals' perspectives. *Circ Cardiovasc Qual Outcomes* 2013;6:18-26.

Switzer J, Singh R, Mathiassen L, Walker J, Adams R, Hess D. Telestroke: Variations in intravenous thrombolysis by spoke hospitals. *J Cerebrovasc Dis* 2015;24(4):739-744.

Taylor DM, Cameron JI, Walsh L, et al. Exploring the feasibility of videoconference delivery of a self-management program to rural participants with stroke. *Telemed J E Health* 2009;15:646-54.

Vaishnav AG, Pettigrew LC, Ryan S. Telephonic guidance of systemic thrombolysis in acute ischemic stroke: safety outcome in rural hospitals. *Clin Neurol Neurosurg* 2008;110:451-54.

Van Hooff RJ, Cambron M, Van DR, De SA, Moens M, Espinoza AV et al. Prehospital unassisted assessment of stroke severity using telemedicine: a feasibility study. *Stroke 2013*; 44(10):2907-2909.

Waite K, Silver F, Jaigobin C, et al. Telestroke: a multi-site, emergency-based telemedicine service in Ontario. *J Telemed Telecare* 2006;12:141-45.

Walter S, Kostopoulos P, Haass A, Keller I, Lesmeister M, Schlechtriemen T et al. Diagnosis and treatment of patients with stroke in a mobile stroke unit versus in hospital: a randomised controlled trial. *Lancet Neurol 2012*; 11(5):397-404.

Wiborg A, Widder B. Teleneurology to improve stroke care in rural areas: The Telemedicine in Stroke in Swabia (TESS) Project. *Stroke* 2003;34:2951-56.

Yaghi S, Harik SI, Hinduja A, Bianchi N, Johnson DM, Keyrouz SG. Post t-PA transfer to hub improves outcome of moderate to severe ischemic stroke patients. *J Telemed Telecare 2015*;21(7):396-9.

Zhai YK, Zhu WJ, Hou HL, Sun DX, Zhao J. Efficacy of telemedicine for thrombolytic therapy in acute ischemic stroke: a meta-analysis. *J Telemed Telecare 2015:21(3):123-130*.

Zaidi SF, Jumma MA, Urra XN, et al. Telestroke-guided intravenous tissue-type plasminogen activator treatment achieves a similar clinical outcome as thrombolysis at a comprehensive stroke center. *Stroke* 2011;42:3291-93.