Implementing telemedicine to support specialist decision making in stroke care during the COVID-19 pandemic

Appendix 1: Case studies

Case study 1: South East Coast Ambulance Service and East Kent Hospitals University Foundation Trust

Dr David Hargroves, *Consultant Physician and Clinical Lead for Stroke Medicine at EKHUFT*

In November 2018, a telemedicine pilot was set up between South East Coast Ambulance and East Kent Hospitals University Foundation Trust to test the feasibility of direct calls between clinicians in order to triage patients who are FAST+ before arrival at hospital.

The pilot sought to explore the feasibility of earlier, ambulance-based triage for FAST+ patients to reduce the number of stroke mimics being conveyed past their local EDs unnecessarily. It also sought to test whether earlier triage by a stroke consultant could potentially speed up 'door-to-needle' times once patients were at hospital by enabling better preparation.

A secure link was set up on FaceTime (via iPad) between South East Coast Ambulance Service NHS Foundation Trust staff based in Thanet and East Kent Hospitals University NHS Foundation Trust consultants in two hospitals. The pilot ran for 5 hours each evening over a 2-week period.

This pilot went through a thorough governance process within South East Coast Ambulance Service NHS Foundation and East Kent Hospitals University NHS Foundation Trust regarding confidentiality and patient safety. There was staff engagement at both sites and communication in person and via email. There was also engagement with a stroke survivor group in Thanet for their views.

The pilot demonstrated that telemedicine can substantially reduce door-to-scanner time by preparing the thrombolysis team before the arrival of the patient. However longer connection times and some poor-quality images were issues that needed to be addressed prior to adoption.

During the COVID-19 pandemic, rapid adoption of FaceTime to 24/7 stroke consultants in hours and neurology registrars out of hours for all equivocal primary stroke patients/minor stroke/TIA patients has been implemented. Analysis of outcomes/experience has been submitted through a National Institute for Health Research (NIHR) COVID-19 grant extension; the following pathway is currently in operation.

Case study 2: Virtual wards rounds in stroke care at Western Sussex Hospitals NHS Foundation Trust

Dr Rajen Patel*, Consultant Stroke Physician, Western Sussex Hospitals NHS Foundation Trust*

With the recent coronavirus outbreak there have been innovative new ways of working using IT in the hospital setting to protect not only our patients but also our staff. Worthing Hospital is a district general hospital with an acute stroke unit providing 24/7 thrombolysis, acute stroke care, ongoing stroke rehabilitation and daily TIA clinics. This work is covered by 3 WTE consultants, and to ensure that we minimised the risk of coronavirus infection to our patients and staff, we decided to adopt virtual ward rounds, utilising and building on our experience with telemedicine, which is already currently being used for hyperacute stroke calls. Fortunately, our IT systems within the trust allow patient observations, blood results, patient notes, imaging and prescription charts all to be viewed electronically. By using FaceTime on a ward iPad, the junior doctors who are physically present with the patients and donned in PPE, would be able to connect to the stroke consultants' iPad for a virtual ward round review. The stroke consultant would have sight of all of the patient information outlined above, allowing them to make decisions akin to them being physically present on a ward round, despite them being in a remote location. The consultant would also be able to make an entry in the medical notes by scribing on a history sheet, which could later be filed in the patients' medical notes.

The small hurdle that we needed to overcome was that the initial medical clerking would not be scanned into the electronic system until discharge (with the rest of the admission notes). Therefore, any new patient to the stroke unit would have their admission notes scanned by the ward clerk, so that they were electronically visible by the stroke consultant on the ward round.

The above process has enabled us to provide effective stroke consultant input to stroke patients with or without coronavirus. It also means that the juniors only have to focus their attention on patient interaction rather than using multiple computer systems while donned in PPE. We have also found that patients do not seem phased by having to speak to a consultant on an iPad screen rather than in person.

This system also allows the stroke consultants to provide rapid reviews in other areas such as the ED, not only for acute stroke calls but also to prevent unnecessary admission to hospital for a stroke review or inappropriate referral to the TIA clinic.

In the scenario where a stroke consultant has to self-isolate but is still well enough to work, the above system could still be implemented from the stroke consultants' home premises, allowing some resilience to be built into the stroke service at that site. It also opens up the possibility of cross-site or organisation working if appropriate IT systems are in place.

All in all the system works well and has multiple benefits, especially with the current coronavirus outbreak. Whether it will replace traditional face-to-face doctor-patient assessment in the future altogether remains to be seen.

Case study 3: NHS Lanarkshire

Professor Mark Barber, *Consultant Geriatrician, NHS Lanarkshire*

(https://journals.sagepub.com/doi/10.1177/0036933013507868)

Prior to the development of the NHS Lanarkshire telestroke network, acute patients presenting to their local Lanarkshire hospital were assessed and then referred to Glasgow for thrombolysis. While an excellent service was provided on arrival, this incorporated large transport delays in the thrombolysis process for those treated and unnecessary transfers if patients were then considered ineligible.

A 'mesh' network was developed; this allowed six consultants from three separate sites to join a single rota covering all three hospitals. During normal working hours, the on-call consultant would provide face-to-face assessments on their own site and telemedicine-based assessments to the other two sites. Out of hours, the assessments would generally be performed using telestroke equipment in the consultant's own home. Nursing staff were trained in neurological examination (NIHSS) to assist in remote neurological assessment as there was not consistent experienced junior doctor cover.

The three stroke units were linked using standard videoconferencing equipment on integrated services digital network lines. Although siting the units in the EDs was considered, it was felt that placing the technology within the stroke area would ensure that the equipment was closely monitored so it would consistently function. The stroke units checked the equipment by dialling into one of the other stroke units on a daily basis.

Because of the importance of a written record of the decision-making process in the patient's clinical record, a system was developed using the Stroke Audit In Lanarkshire (SAIL) software to allow stroke specialists to record the clinical findings electronically from home – or a distant hospital – and have this record immediately printed off in the stroke unit and filed in the patient's case record. The clinical record included important times with regard to the stroke journey and initiated the audit process for the assessed patient.

Case study 4: East of England

Lynda Sibson, *Telemedicine Manager, East of England Stroke Telemedicine Stakeholder Partnership*

The out-of-hours East of England regional stroke telemedicine service was introduced in 2010 to address the inequitable access to stroke thrombolysis across the region. The East of England is a largely rural area covering 7,500 square miles with a population of 5.6 million. With an estimated 6,000 patients per annum presenting with a stroke, providing timely access to stroke thrombolysis across this wide and largely rural population was a challenge.

From November 2010, a videoconferencing telemedicine software solution, *Visionable*, currently hosted in a secure Amazon cloud, allowed the stroke consultants to rapidly link with the referring hospital, providing real-time, rapid access to stroke expertise when and where it was required. Prior to telemedicine, many stroke patients were transferred between hospitals to access thrombolysis, only to be outside the timeframe for treatment on arrival at the treating hospital.

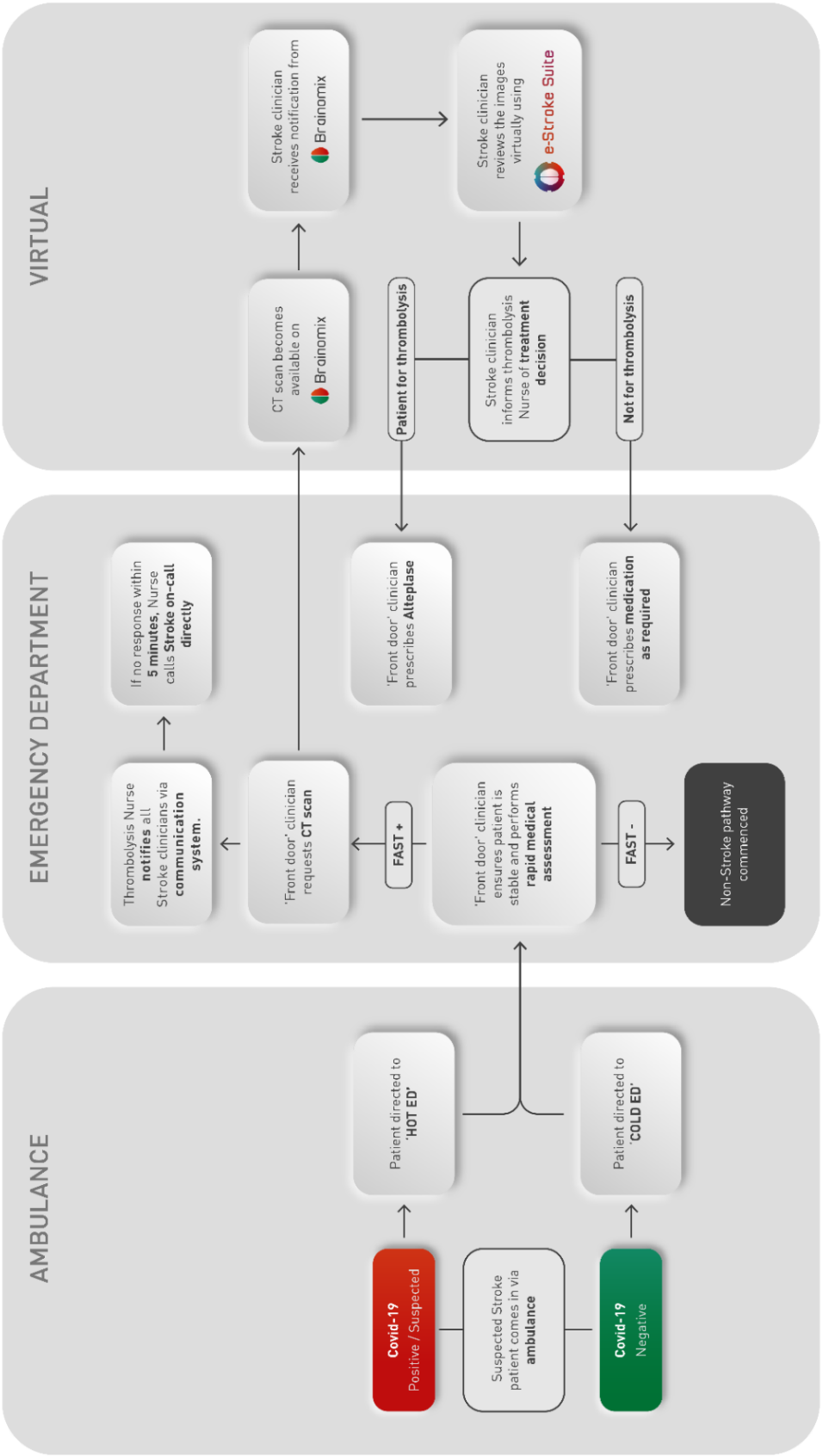
The stroke telemedicine consultants are also able to securely access the patient's CT scan via the image exchange portal (IEP) system. The IEP allows each hospital to transmit the patient's CT scans through to our dedicated 'blue-light' institution. The CT scanners at the referring hospital are linked with the IEP system, enabling automatic routing of the relevant CT scans out of hours. The stroke telemedicine consultants are then able to access the internet-based web browser and review the patient's CT scan via a three-factor authentication process. If the patient's CT scan is not available via IEP, the *Visionable* software has a desktop-sharing feature, enabling the local stroke team to access their local PACS on the stroke telemedicine cart and share this view with the stroke telemedicine consultant.

Each hospital has two telemedicine carts; one based in the ED and one based on the hyperacute stroke unit (HASU). Each cart is a mobile, wireless-enabled trolley, housing a hospital-specific PC that runs the telemedicine software and is easily moved to the end of the patient's bed, as needed. The on-call stroke telemedicine consultant is based at home, with a standard laptop, using the *Visionable* software, enabling them to clearly see and hear the patient, their relatives and the local clinical team in a 'virtual' consulting room.

Case study 5: Royal Berkshire NHS Foundation Trust

Dr Kiruba Nagaratnam, *Consultant Stroke Physician and Geriatrician, Royal Berkshire NHS Foundation Trust*

The Royal Berkshire NHS Foundation Trust have worked with Brainomix to develop a novel working practice to support remote decision working during the COVID-19 pandemic. A full report of this initiative can be found on the Oxford AHSN website (www.oxfordahsn.org/our-work/covid-19/covid-19-case-studies/ai-technology-speeds-up-stroke-care-and-reduces-costs/). The pathway is shown on page 32.


AMBULANCE
Covid-19 Positive / Suspected
Suspected Stroke patient comes in via ambulance
Covid-19 Negative
Patient directed to 'HOT ED'
Patient directed to 'COLD ED'
EMERGENCY DEPARTMENT
'Front door' clinician ensures patient is stable and performs rapid medical assessment
FAST -
Non-Stroke pathway commenced
FAST +
'Front door' clinician requests CT scan
Thrombolysis Nurse notifies all Stroke clinicians via communication system.
If no response within 5 minutes, Nurse calls Stroke on-call directly
'Front door' clinician prescribes Alteplase
'Front door' clinician prescribes medication as required
VIRTUAL
Stroke clinician informs thrombolysis Nurse of treatment decision
Patient for thrombolysis
Not for thrombolysis
CT scan becomes available on Brainomix
Stroke clinician receives notification from Brainomix
Stroke clinician reviews the images virtually using e-Stroke Suite

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Appendix 2: Suggested data capture sheet – telemedicine thrombolysis for acute ischaemic stroke

Patient name:

Patient identifier or DOB:

Telestroke consultant:

Referring hospital:

Name of referrer:

Date of call:

Time of call (24-hour clock):

Time of onset/last well:

History:

Past medical history:

Current medication:

Examination: NIHSS:

BP:

BM:

Date of CT scan:

Time of scan (24-hour clock):

CT interpretation

Diagnosis:

Contraindications:

Recent intracranial bleeding:

Other relevant factors taken account of (delete if not present):

Known low platelets

Prior ICH

Ischaemic stroke within 3 months

Recent surgery

Recent major trauma

Recent bleeding at non compressible site

Pregnant /recent delivery

Suspected subarachnoid haemorrhage (SAH)

Seizure at onset

SBP >185 DBP >110

Time of recommendation (24-hour clock):

Treatment recommendation (delete a or b, and edit if appropriate)

a. Thrombolysis recommended
   - Discuss risks and benefits of treatment, including risk of fatal intracranial haemorrhage. In this case, potential benefits outweigh risks
   - Dose 0.9 mg/kg alteplase, 10% as bolus rest over one hour (max dose 90 mg)
   - Avoid antiplatelets and anticoagulants for 24 hours then review after repeat imaging
   - Integrated stroke unit (ISU), HASU – if not available discuss HDU vs AMU
   - CT scan at approximately 24 hours
   - Swallow assessment within 4 hours
   - Assess need for intermittent pneumatic compression (IPC)

b. Thrombolysis NOT recommended because: _____
   - Swallow assessment within 4 hours
   - Aspirin 300 mg stat if no contraindication, then 300 mg daily (oral/NG/rectal)
   - Stroke unit care asap
   - Assess need for IPC

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Appendix 3: Recognition of Stroke in the Emergency Room (ROSIER)[1]

(www.thelancet.com/journals/laneur/article/PIIS1474-4422(05)70201-5/fulltext)

Date/time of symptom onset _____

GCS E= M= V= BP *Glucose

* If blood glucose < 3.5 mmol/l treat urgently and reassess once blood glucose normal

Has there been loss of consciousness or syncope?	Y(-1)	☐	N(0)	☐
Has there been seizure activity?	Y(-1)	☐	N(0)	☐
Is there a NEW ACUTE onset or on awakening from sleep				
Asymmetric facial weakness	Y(1)	☐	N(0)	☐
Asymmetric arm weakness	Y(1)	☐	N(0)	☐
Asymmetric leg weakness	Y(1)	☐	N(0)	☐
Speech disturbance	Y(1)	☐	N(0)	☐
Visual field defect	Y(1)	☐	N(0)	☐

** Total Score _____ (-2 to +5)

Admit to Acute Stroke Unit / Refer to stroke team if total score > 0 (score between 1 and 5)

Brief training videos can be accessed here (flash player required)

- www.strokeadvancingmodules.org/labyrinth/mnode_client.asp?id=29852

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Appendix 4: National Institutes of Health Stroke Scale

NIH_Stroke_Scale_508C.pdf

1a	**Level of consciousness (LOC):** 0 = Alert; keenly responsive 1= Not alert, but arousable by minor stimulation to obey, answer or respond 2 = Not alert, requires repeated stimulation to attend, or is obtunded and requires strong or painful stimulation to make movements (not stereotyped) 3 = Responds only with reflex motor or autonomic effects or totally unresponsive, flaccid, areflexic	
1b	**LOC questions:** 0 = Answers both questions correctly 1 = Answers one question correctly 2 = Answers neither question correctly	
1c	**LOC commands:** 0 = Performs both tasks correctly 1 = Performs one task correctly 2 = Performs neither task correctly	
2	**Best gaze:** 0 = Normal 1 = Partial gaze palsy. This score is given when gaze is abnormal in one or both eyes, but where forced deviation or total gaze paresis are not present 2 = Forced deviation, or total gaze paresis not overcome by the oculocephalic manoeuvre	
3	**Visual:** 0 = No visual loss 1 = Partial hemianopia 2 = Complete hemianopia 3 = Bilateral hemianopia (blind including cortical blindness)	
4	**Facial palsy:** 0 = Normal symmetrical movement 1 = Minor paralysis (flattened nasolabial fold, asymmetry of smiling) 2 = Partial paralysis (total or near total paralysis of lower face 3 = Complete paralysis of one or both sides (absence of facial movement in the upper and lower face)	

5	**Motor arm:** 0 = No drift, limb holds 90 (or 45) degrees for full 10 seconds 1 = Drift, limb holds 90 (or 45) degrees, but drifts down before full 10 seconds, does not hit bed or other support 2 = Some effort against gravity, limb cannot get to or maintain (if cued) 90 (or 45) degrees, drifts down to bed, but has some effort against gravity 3 = No effort against gravity, limb falls 4 = No movement A = Amputation, joint fusion, explain: _____	**5a Left** _____ **5b Right** _____
6	**Motor leg:** 0 = No drift, leg holds 30 degrees position for full 5 seconds 1 = Drift, leg falls by the end of the 5-second period but does not hit bed 2 = Some effort against gravity, leg falls to bed by 5 seconds, but has some effort against gravity 3 = No effort against gravity, leg falls to bed immediately 4 = No movement A = Amputation, joint fusion, explain: _____	**6a Left** _____ **6b Right** _____
7	**Limb ataxia:** 0 = Absent If present, is ataxia: (circle each limb YES or NO) 1 = Present in one limb Right arm: YES NO Left arm: YES NO 2 = Present in two limbs Right leg: YES NO Left leg: YES NO Amputation, joint fusion, explain: _____	
8	**Sensory:** 0 = Normal, no sensory loss 1 = Mild-to-moderate sensory loss, patient feels pinprick is less sharp or is dull on the affected side, or there is a loss of superficial pain with pinprick but patient is aware he/she is being touched 2 = Severe-to-total sensory loss, patient is not aware of being touched in the face, arm, and leg	

9	**Best language:** 0 = No aphasia, normal 1 = Mild-to-moderate aphasia, some obvious loss of fluency or facility of comprehension, without significant limitation on ideas expressed or form of expression. Reduction of speech and/or comprehension; however, makes conversation about provided material difficult or impossible 2 = Severe aphasia, all communication is through fragmentary expression, great need for inference, questioning and guessing by the listener. Range of information that can be exchanged is limited, listener carries burden of communication 3 = Mute, global aphasia, no usable speech or auditory comprehension	
10	**Dysarthria:** 0 = Normal 1 = Mild-to-moderate, patient slurs at least some words and, at worst, can be understood with some difficulty 2 = Severe, patient's speech is so slurred as to be unintelligible in the absence of or out of proportion to any dysphasia, or is mute/anarthric A = Intubated or other physical barrier, explain _____	
11	**Extinction and inattention (formerly Neglect):** 0 = No abnormality 1 = Visual, tactile, auditory, spatial or personal inattention or extinction to bilateral simultaneous stimulation in one of the sensory modalities 2 = Profound hemi-inattention or hemi-inattention to more than one modality, does not recognise own hand or orients to only one side of space	
	Total	

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Appendix 5: Angels Initiative resources

You will need to register with the Angels Initiative to access the following resources:

- Slides and training videos for staff working in the ED and on the wards
  www.angels-initiative.com/angels-academy
- Hyperacute video simulations in a hospital
  www.angelsinitiative.com/academy/hyperacute/workshop-guidance
- Post-acute, Fever, Sugar, Swallow (FeSS) checklists and Acute Screening of Swallow in Stroke/TIA (ASSIST) training for dysphagia screening
  www.angels-initiative.com/academy/post-acute/checklist

Suggested protocol for ED nurse

(Adapted from ANGELS Initiative)

Work in parallel with medical staff to save time.

Objective: Confirm diagnosis of stroke and perform initial physical examination to provide the treating physician with the relevant information in less than 10 minutes.

Stroke screening – FAST

	Normal	Abnormal
Facial droop	Both sides of face move equally	One side of face does not move at all
Arm drift	Both arms move equally or not at all	One-arm drifts compared to the other
Speech	Patient uses correct words with no slurring	Slurred or inappropriate words or mute

If the patient has **any** features in the abnormal column, or if you receive ambulance pre-notification of suspected FAST positive patient, **activate the stroke pathway**.

Stroke pathway

- ED doctor to contact networked stroke physician on-call
- Inform radiology to prepare CT scanner for stroke patient
- Inform laboratory of stroke patient incoming
- Immediate transfer to CT scanner
- Establish IV access (preferably two medium-large bore cannulas with saline lock) and start crystalloid infusion

Collect the following information within 5 minutes

- Blood sugar by finger prick (advise doctor if blood glucose <50 mg/dl or >180 mg/dl)
- Point-of-care INR (advise doctor if patient is taking anticoagulant)
- Determine patient weight (use stroke bed to determine weight, alternatively ask family or estimate)
- Time from symptom onset (advise doctor if >4.5 hours)
- Patient's age (advise doctors if patient is <18 or >80 years of age)

Monitor the following parameters

- Start on O_2 (2–4 l/min nasal cannula to keep O_2 saturation >94%)
- Connect to continuous cardiac monitoring
- Temperature

- Heart rate
- Respiratory rate

Draw blood for the following

- Complete blood and platelet count
- Partial thrombin time (PTT)
- Serum electrolytes
- Blood glucose
- CRP or sedimentation rate
- Hepatic and renal chemical analysis

Keep the following points in mind

- Incline head of bed at 30°
- If indicated, insert urinary catheter before starting alteplase (do not delay the initiation of alteplase for this)
- Apply pressure dressing on any failed vein puncture sites
- Avoid NG tubes, if possible, for 24 hours
- Keep nil by mouth until swallow screen has been done; if dysphagia is present, keep nil by mouth

Suggested protocol for ED physician (prior to thrombolysis decision being made)

(Adapted from ANGELS Initiative)

Objective: Confirm diagnosis of stroke and perform initial physical evaluation in less than 10 minutes

- Ascertain time of symptom onset (when was the patient last seen well?)
  - <4 hours ago
  - >4 hours ago
  - Unknown
- Take history
- Assess NIHSS score
- Assess modified Rankin score
- Assess for absolute contraindications for alteplase
- Review laboratory results
- Contact stroke consultant

Modified Rankin score

0 = No symptoms

1 = Able to carry out all usual duties and activities

2 = Unable to carry out all previous activities but able to look after own affairs without assistance

3 = Requires some help but able to walk without assistance

4 = Unable to walk without assistance and unable to attend to own bodily need without assistance

5 = Bedridden, incontinent and requiring constant nursing care and attention

(6 = Dead)

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Appendix 6: Thrombolysis checklist – factors associated with a higher risk of complication and/or bleeding

This checklist needs to be completed in full. Any tick in the YES column represents key information that needs to be highlighted to the remote stroke physician. This may not necessarily be a contraindication to thrombolysis.

	Yes	No
Factors associated with higher risk of bleeding		
Significant bleeding disorder at present or within the past 6 months		
Known haemorrhagic diathesis		
Patients receiving effective oral anticoagulant treatment, e.g. warfarin sodium (INR >1.7)		
Manifest or recent severe or dangerous bleeding		
Known history of or suspected intracranial haemorrhage		
Suspected subarachnoid haemorrhage or condition after subarachnoid haemorrhage from aneurysm		
Prior stroke within the l[ast 3 months		
Any history of central nervous system damage (i.e. neoplasm, aneurysm, intracranial or spinal surgery)		
Recent (less than 10 days) traumatic external heart massage, obstetrical delivery, recent puncture of a non-compressible blood-vessel (e.g. subclavian or jugular vein puncture)		
Severe uncontrolled arterial hypertension		
Bacterial endocarditis, pericarditis		
Acute pancreatitis		
Documented ulcerative gastrointestinal disease during the last 3 months, oesophageal varices, arterial aneurysm, arterial/venous malformations		
Neoplasm with increased bleeding risk		
Severe liver disease, including hepatic failure, cirrhosis, portal hypertension (oesophageal varices) and active hepatitis		
Major surgery or significant trauma in past 3 months		
Evidence of ICH on the CT scan		
Symptoms suggestive of subarachnoid haemorrhage, even if CT scan is normal		

Administration of an anticoagulant medication within the previous 48 hours		
Platelet count <100,000/mm^3		
SBP >185 mmHg or DBP >110 mmHg, or aggressive management (intravenous pharmacotherapy) necessary to reduce BP to these limits		
Considerations based on time		
Symptoms of ischaemic attack beginning: • more than 4.5 hours prior to infusion start, or • if unknown onset, last known well more than 4.5 hours ago		
Considerations based on stroke severity		
Non-disabling neurological deficit or symptoms improved before start of infusion		
Severe stroke as assessed clinically (e.g. NIHSS >25) and/or by appropriate imaging techniques		
Additional considerations		
Seizure at onset of stroke		
Any history of prior stroke and concomitant diabetes		
Blood glucose <50 mg/dl or >400 mg/dl (<2.8 mM or > 22.2 mM)		

Alteplase dosage and administration

Use the dosing table below (www.medicines.org.uk/emc/product/898/smpc) to determine the total dose.

The recommended total dose is 0.9 mg alteplase/kg body weight (maximum of 90 mg) starting with 10% of the total dose as an initial intravenous bolus, immediately followed by the remainder of the total dose infused intravenously over 60 minutes.

Dosing table for acute ischaemic stroke

By using the recommended standard concentration of 1 mg/ml, the volume (ml) to be administered is equal to the recommended dosing value (mg)

Weight (kg)	Total dose (mg)	Bolus dose (mg)	Infusion dose* (mg)
40	36.0	3.6	32.4
42	37.8	3.8	34.0
44	39.6	4.0	35.6
46	41.4	4.1	37.3
48	43.2	4.3	38.9
50	45.0	4.5	40.5
52	46.8	4.7	42.1
54	48.6	4.9	43.7
56	50.4	5.0	45.4
58	52.2	5.2	47.0
60	54.0	5.4	48.6
62	55.8	5.6	50.2
64	57.6	5.8	51.8
66	59.4	5.9	53.5
68	61.2	6.1	55.1
70	63.0	6.3	56.7
72	64.8	6.5	58.3
74	66.6	6.7	59.9
76	68.4	6.8	61.6
78	70.2	7.0	63.2
80	72.0	7.2	64.8
82	73.8	7.4	66.4
84	75.6	7.6	68.0
86	77.4	7.7	69.7
88	79.2	7.9	71.3
90	81.0	8.1	72.9
92	82.8	8.3	74.5
94	84.6	8.5	76.1
96	86.4	8.6	77.8
98	88.2	8.8	79.4
100+	90.0	9.0	81.0

*Given in a concentration of 1 mg/ml over 60 minutes as a constant rate infusion.

- Use as few vials of alteplase as possible to draw up dose.
- Reconstitute vial using the supplied preservative-free water for injection. Do not shake the vial to expedite this process.
- The concentration of the reconstituted alteplase is 1 mg/ml.
- Bolus dose:
  - The bolus dose is 10% of total calculated alteplase dose.
  - Use a 10-ml syringe to draw up the prescribed bolus dose directly from alteplase vial. Dosing and volume should be checked by two qualified members of staff (medical or nursing).
  - Administer the bolus dose by direct IV push over 1–2 minutes.
  - Document the timing of bolus dose administration.
- Infusion dose:
  - The infusion dose is the remaining 90% of total calculated alteplase dose.
  - It should be drawn up in one or two 50-ml Luer-Lok syringes, dependent on the dose to be administered. These should be labelled according to standard policy.
  - The syringe(s) should be connected in turn to infusion tubing primed with alteplase and placed in an IV syringe pump.
  - Prior to attaching the infusion tubing to the patient, ensure the following:
    - The cannula to be used for the infusion is patent.
    - The BP cuff is attached to the other arm.
    - The pump infusion rate (ml/hr) should be set at the infusion dose over 1 hour given that the concentration of the reconstituted alteplase is 1 mg/ml.
    - Document the timing of commencement of the infusion.

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Appendix 7: Complications following thrombolysis

Haemorrhage within 48 hours of alteplase administration

- If haemorrhage is suspected, either intracranial or extracranial, the first action should be to stop the infusion of alteplase, if it is still running, and/or antithrombotic treatment while definitive investigations take place.
- There may be a role for fibrinolysis inhibition and/or fibrinogen replacement following discussion with haematology.

Intracranial haemorrhage

- Suspect if:
  - increased neurological deficit/deteriorating LOC
  - new or increasing headache
  - acute hypertension (two successive BP readings >185/110 mmHg)
  - nausea and vomiting
- Actions:
  - Stop alteplase infusion
  - Contact stroke consultant
  - Arrange immediate CT brain scan
  - Take bloods for:
    - full blood count
    - coagulation screen
    - fibrinogen, fibrin degradation products (FDPs)
    - Ensure Group and Save in place
  - If diagnosis confirmed:
    - administer fresh frozen plasma (FFP) 12 ml/kg
    - administer IV tranexamic acid 1 g tds
    - discuss with haematology and potentially with neurosurgery

Extracranial haemorrhage

- Superficial bleeding (Venflon sites, venepuncture sites)
  - If the patient is haemodynamically stable, continue intravenous infusion of alteplase.
  - Apply direct pressure dressing and/or ice packs, if required
- Major bleeding
  - Suspect if:
    - hypotension
    - new local symptoms or signs (BP, abdominal or back pain)
  - Actions:
    - Stop alteplase infusion
    - Contact acute stroke consultant
    - Take bloods for:
      - full blood count
      - coagulation screen
      - fibrinogen
      - Ensure Group and Save in place
    - Ensure patent IV access

        - Resuscitate with IV fluids/blood, as appropriate
        - Investigate and inform specialist colleagues dependent on suspected source of haemorrhage
        - Administer FFP 12 ml/kg
        - Administer IV tranexamic acid 1 g tds
        - Discuss with haematology
- Haematology guidance for either intracranial or extracranial haemorrhage may include:
    - administration of cryoprecipitate or fibrinogen concentrate if there is depletion of fibrinogen
    - further therapy, which may be guided by results of coagulation tests.

Anaphylaxis

- Suspect if:
    - rash/urticaria
    - bronchospasm
    - angio-oedema
    - hypotension/shock
- Actions:
    - Stop alteplase infusion
    - Ensure airway secure and give 100% oxygen, unless contraindicated
    - Contact acute stroke consultant
    - Consider giving immediately the following:
        - Chlorpheniramine 10 mg IV
        - Hydrocortisone 200 mg IV
        - Epinephrine 500 micrograms IM (0.5 ml of 1:1000)
        - Rapid bolus infusion of normal saline
        - Salbutamol 2.5–5 mg nebulised
    - Ensure regular observations
    - If fails to respond to initial treatment, contact ICU as an emergency
    - In addition, consider use of C1 esterase inhibitor if cause felt to be true angio-oedema

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Appendix 8: Nursing observations required post-thrombolysis

Arrival on the ward

- All stroke patients should be 'nil by mouth' for the first 24 hours or until the next acute stroke consultant review.
- NG tube and urinary catheter placement should be avoided wherever possible for the first 24 hours following thrombolysis. Every effort should be made to toilet the patient prior to consideration of a urinary catheter.
- All thrombolysed patients require an intensive schedule of monitoring, as outlined below, and should be attached to continuous monitoring.

On arrival on the ward

- BP
- Heart rate
- Respiration rate
- Oxygen saturation
- Temperature
- Neurological observations (Glasgow Coma Scale score, pupils, limb movement)
- Check all puncture sites for bleeding
- Check tongue for swelling

First 2 hours after thrombolysis

- Every 15 minutes:
  - BP
  - Heart rate
  - Respiration rate
  - Oxygen saturation
  - Check all puncture sites for bleeding
  - Check tongue for swelling
- Each hour:
  - Temperature
  - Neurological observations (Glasgow Coma Scale score, pupils, limb movement)

Next 6 hours

- Every 30 minutes:
  - BP
  - Heart rate
  - Respiration rate
  - Oxygen saturation
  - Check all puncture sites for bleeding
- Each hour:
  - Temperature
  - Neurological observations (Glasgow Coma Scale score, pupils, limb movement)

Next 16 hours

- Each hour:
  - BP
  - Heart rate
  - Respiration rate
  - Oxygen saturation
  - Check all puncture sites for bleeding
  - Temperature
  - Neurological observations (Glasgow Coma Scale score, pupils, limb movement)

Thereafter (i.e. between 24 and 72 hours after admission)

- Follow the FeSS protocol (https://www.sciencedirect.com/science/article/pii/S0140673611614852) for the next 48 hours, then routine observations thereafter, unless additional observations indicated.

Special notes

- All BP, pulse and oxygen saturation measurements should be taken from the unaffected arm, unless contraindicated.
- Manual BP measurement must occur to confirm BP >185/110 mmHg or if the patient is hypotensive.

Actions

- Within the first 24 hours on the acute stroke unit, report immediately to doctor if:
  - SBP >185 mmHg
  - DBP >110 mmHg
  - Heart rate >100 beats per minute
  - Heart rhythm changes
  - Rate or nature of respiration changes
  - Neurological state deteriorates
  - Bleeding occurs
  - Temperature rise of 1°C from baseline.

Delivering safe stroke care at hospitals without acute stroke units during the COVID-19 pandemic

Appendix 9: Benefits and risks of thrombolysis

(Taken from East of England SOP)

- Thrombolysed patients are 32% more likely to have little or no deficit at 3 months
- For every 100 patients treated:
  - 32 better, 3 worse, 65 unchanged
- IV alteplase 10 times more likely to help than harm
- Risk of bleeding 3–6%; 1–2% will suffer significant ICH/gastrointestinal bleed, which in severe cases may lead to worsening symptoms or death
- The earlier the treatment within 4.5-hour window, the better the outcome
- Rare risk of hypotension and/or angioedema

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Appendix 10: Summary guide to thrombolysis

(Adapted from Oxford University Hospitals NHS FT guidance)

Scope

This document provides a ***summary guide*** covering the practicalities for the initial assessment of patients with acute stroke arriving at the ED.

A support document, the 'thrombolysis checklist', is available in Appendix 6 and should be kept in the ED. This should be used in real-time to help support screening for contraindications to thrombolysis, informing the consent processes and dosing alteplase.

Acute stroke care is supported remotely by a specialist stroke consultant, with 24/7 availability.

This document is designed to provide a structured approach to initial assessment. Using such a structured approach will support remote decision making by stroke consultants. It will also support fast times to treatment. Stroke is a time-critical emergency and thrombolysis should be administered as soon as possible and ideally within 30 minutes of arrival to eligible patients.

Pre-alerts and stroke calls

Paramedic teams should pre-alert the ED for all suspected stroke patients arriving at the ED. The radiography team should also be notified.

As soon as the ED team has secured the details, these should be relayed to the networked stroke consultant without personal details. This is typically via call to mobile phone or messenger service (WhatsApp, etc).

It is good practice for the ED team to contact the stroke consultant at the beginning of each shift to ensure each has the other's contact details to facilitate communication in the event of a stroke call.

Assessment on arrival

A focussed assessment should be carried out. A thrombolysis checklist (see **Appendix 6**) should be kept in the ED.

The patient should normally be assessed in the resuscitation bay of the ED.

Key factors to determine:

- **Is this likely to be a stroke?** Abrupt onset, focal neurological deficit, absence of severe haemodynamic or metabolic disruption.
- **Are there any features to suggest an alternative diagnosis?** This would include seizure, LOC, worsening symptoms of previous stroke, known brain tumour or metastases, recurrent stereotyped symptoms, strong suggestion of functional presentation.
- **When was the patient last known to be well?** If the patient woke with symptoms or the time is unknown, when were they last known to be well? *Call a witness if needed.*
- **What is the severity of the stroke?** This does not need to be a full NIHSS breakdown unless you are competent to acquire this quickly – for example, it is sufficient to say dense left-sided weakness affecting face, arm and leg with dysarthria.
- **What is the premorbid functional status?** Summary is sufficient, e.g. level of dependency, walking ability and aids, cognitive status.
- **What is the blood pressure and capillary glucose?** *The glucose can be from the paramedic assessment.*
- **Are there any additional considerations relating to thrombolysis?** Important information includes current anticoagulation, previous haemorrhage, recent stroke, recent operations, pregnancy. Note there

are few absolute contraindications and **these should usually be discussed with the stroke consultant directly.**

After the initial assessment, ***please briefly update the stroke consultant*** and organise urgent imaging.

Investigations

After the targeted initial assessment, the ***key investigation is the CT scan of the brain***. Unless there is a clear contraindication, this should include CTA of the head and neck. Recent renal function is **not** required before CTA. Venous access is required.

- These should **not** need to be discussed with the duty radiologists, and the radiographer should agree to do these routinely.
- Check the CT radiographer can accommodate the scan and which scanner is to be used. This should happen at the next available opportunity.
- Escort the patient to the CT scanner as soon as possible and help the radiographer move the patient onto the scanner table.
- Once imaging is acquired, make the stroke consultant aware and await instruction regarding thrombolysis.
- Imaging should not be delayed for an ECG or changing clothes, unless awaiting the scanner.
- Physiological monitoring should be used to transfer the patient to the CT scanner, unless clearly not needed.

Thrombolysis

A record of the discussion around decision making, including risks and benefits of thrombolysis with the patient or their advocate, should be recorded where the patient is able to engage in this discussion. A summary of the salient points is included in the thrombolysis checklist (**Appendix 6**).

For a comprehensive guide to thrombolysis contraindications, see the thrombolysis checklist (**Appendix 6**).

If a decision to deliver thrombolysis is made, ***it may be necessary to first lower the BP if either SBP is over 185 mmHg or DBP over 110 mmHg***. First-line BP medication is 10–20 mg IV labetalol, escalating under guidance of the stroke consultant. Second-line agent is IV glyceryl trinitrate (GTN) infusion. Discuss with the stroke consultant for details.

Thrombolysis for stroke uses ***alteplase***. This should be kept in the drug cupboard in the ED.

Dosing is by reported or estimated weight (0.9 mg/kg), and a look-up table is available in the thrombolysis checklist (**Appendix 6**)**.** A weighting pat slide is a time-efficient way of obtaining body weight to calculate alteplase dose.

A bolus is given (10% of total dose) as a push IV injection, followed by the remaining dose over 1 hour.

The bolus dose can be mixed from a 10-mg set of vials for reconstitution. The diluent and powder are provided in the pack. These are to be mixed using a standard syringe and drawing up needle. Mixing should be done by rolling the mixed vial until the powder has dissolved. The timing of the bolus delivery should be documented in the notes and the drug chart.

ED nurses can set up the infusion. Patients should remain in ED until the infusion is complete. After this time, patients can be moved to a monitored bay on a ward.

Thrombolysis should be stopped if there is concern over intracranial bleeding (worsening neurological deficit, reduced conscious level, worsening headache, acute severe hypertension, nausea and vomiting) and the patient rescanned. Contact the stroke consultant and administer FFP and tranexamic acid. Thrombolysis should also be stopped in the presence of extracranial bleeding or anaphylaxis (hypotension or angioedema with lip/tongue swelling).

The ***coagulopathy associated with thrombolysis can last up to 24 hours***, meaning BP control targets and haemorrhagic management remain the same for the first 24 hours.

Post-acute management

A few tips:

- Formally document the NIHSS in the clerking (online training is available at www.nihstrokescale.org/).
- Patients should be admitted within 4 hours to the stroke unit directly from ED.
- Venous thromboembolism (VTE) prophylaxis is normally managed using intermittent pneumatic compression devices. Do not give dalteparin unless advised by the stroke consultant.
- Patients are nil by mouth and kept hydrated with saline.
- Prescribe IV paracetamol as required.
- If thrombolysis is given, do not give concurrent aspirin or clopidogrel acutely.
- The stroke consultant will advise about thrombectomy options.

If in doubt about any aspect of the management, please contact the stroke consultant directly.

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Appendix 11: Key points for the management of haemorrhagic stroke

ICH will be confirmed by the CT scan, and patients should be discussed with the remote stroke physician, who will advise on management and any onward referral to neurosurgery.

Key points for the management of ICH (www.nice.org.uk/guidance/ng128/chapter/Recommendations) include:

1. Reversal of anticoagulation treatment
   1.2 Return clotting levels to normal as soon as possible in people with a primary ICH who were receiving warfarin before their stroke (and have elevated INR). Do this by reversing the effects of the warfarin using a combination of prothrombin complex concentrate and intravenous vitamin K.

2. BP control
   2.2 *Offer* rapid BP lowering to people with acute ICH who do not have any of the exclusions in 2.4 below and who:
   - present within 6 hours of symptom onset

   and
   - have SBP between 150 and 220 mmHg.

   Aim for SBP target of 130–140 mmHg within 1 hour of starting treatment and maintain this blood pressure for at least 7 days.

   2.3 *Consider* rapid BP lowering for people with acute ICH who do not have any of the exclusions listed in 2.4 below and who:
   - present beyond 6 hours of symptom onset

   or
   - have SBP >220 mmHg.

   Aim for SBP target of 130–140 mmHg within 1 hour of starting treatment and maintain this blood pressure for at least 7 days.

   2.4 Do ***not*** offer BP lowering to people who:
   - have an underlying structural cause (for example, tumour, arteriovenous malformation or aneurysm)
   - have a score on the Glasgow Coma Scale <6
   - are going to have early neurosurgery to evacuate the haematoma
   - have a massive haematoma with poor expected prognosis.

3. Referral for neurosurgery
   3.1 The remote stroke physician will advise on the need for neurosurgery referral.

Developing virtual clinics for managing TIA and minor stroke during the COVID-19 pandemic

Appendix 12: Case study examples

Case study 1: Wirral University Teaching Hospital NHS Foundation Trust

Dr Deb Lowe, *Consultant Stroke Physician and Geriatrician, Wirral University Teaching Hospital NHS Foundation Trust; National Clinical Director for Stroke Medicine, NHSE&I*

Wirral University Teaching Hospital has been delivering tele-triage for all TIA/minor stroke referral for almost 10 years. Referrals are received via e-mail on a standard proforma from GPs and the ED. The initial telephone assessment is completed by an experienced stroke nurse specialist, with same-day discussion with the 'hot-week' stroke consultant, a subsequent next day 'one-stop' TIA clinic. Since the COVID-19 pandemic, tele-triage has continued, but face-to-face clinics have been replaced by telephone consultations, or on occasion by video calls, initially using WhatsApp or FaceTime. Consultations are supported by a thorough stroke specialist nurse history to ensure efficient use of consultant time, using a structured approach with a checklist. The consultation generates a clinic letter in the same way a face-to-face consultation would. The electronic health record is also used to record all virtual telephone conversations.

During the call, the clinician takes history following the usual clinic format. Patients are asked to do a pulse check to determine whether it feels irregular, if the clinician feels the patient is able to do this. As about half of patients, mostly elderly, are unable to identify their own pulse, remote solutions for obtaining BP and pulse are being investigated.

Four main groups of patients are identified at this stage:

- Definite TIA or minor stroke from initial history
- Not TIA from initial history but needs rapid assessment and management via TIA clinic, e.g. suspected space-occupying lesion
- Likely other diagnoses best assessed by another clinic; these patients are referred on to another clinic, although this option may become less available in the current crisis and investigations may be undertaken
- Not TIA/other diagnosis that does not need consultation; no appointment is required, so reassurance is given.

For patients with definite TIA/minor stroke, investigations are arranged, including blood tests, rhythm strip/ECG and brain imaging, MRI being the first line of investigation for TIA. To minimise waiting times at hospital for brain imaging, tests should be booked in ahead

Clinical AF is treated immediately, with at least a rhythm strip required before blood-thinning drugs are prescribed. DOACs should be prescribed rather than warfarin unless absolutely contraindicated (e.g. end-stage renal failure or creatinine clearance [CrCl] <20 ml/min). With respect to COVID-19, new guidance on prescribing of DOACs is followed and existing use of NSAIDs is reviewed.

Patients are followed up at 1 month with a further telephone consultation to ensure they have had all the necessary investigations, they are taking the necessary secondary prevention, and they understand their risk factors and diagnosis. All patients, if they consent, are referred for follow up to the Stroke Association commissioned service for community support Those with minor stroke (e.g. speech problems or ongoing limb weakness but still functionally able to manage at home) are referred to the stroke specific ESDT from clinic, to be seen within 48 hours.

Case study 2: East Kent Hospitals University Foundation Trust

Dr David Hargroves, *Consultant Physician and Clinical Lead for Stroke Medicine at EKHUFT*

Dr Hargroves has been running virtual clinics from the start of the COVID-19 crisis, triaging about 60 people within the first month. This has allowed patients to be filtered out at each stage of the process, with referrals requiring a face-to-face consultation reduced by 30–40%.

All virtual triage is currently led by a consultant, with calls made from a quiet location that will not be disturbed. Virtual consultations are most successful when they follow the usual template for normal outpatient clinic; they do tend to take longer than a normal consultation, but this improves with time as the consultant becomes more familiar with the new format.

Both patient and clinician prepare before the call. The patient is prewarned about the timing of the call and asked to be sat down and ready for a 20-minute consultation, with a list of medicines and information about relevant previous medical history to hand. The consultant reviews existing records, including blood tests and brain scans, to get a picture of the patient before the call and identify what information needs to be obtained during the call.

A history is taken as usual, including the reason for referral and the drug history, which provides useful information about their current medical history to set the context for the call. Patients are asked about any concerns and what they think is happening so that immediate concerns can be discussed and reassurance given. The consultant concludes the call by sharing their impression about the patient's condition, giving the differential diagnosis, explaining the treatment plan and investigation timeline, and discussing any issues arising from the diagnosis, including driving, flying and tablets.

Until community settings for testing and remote solutions for monitoring are in place, patients who require investigations, including BP, ECG (rhythm strip) and brain imaging, are asked to attend the hospital. Only about 30% of patients identified as having definite TIA through this virtual triage approach will require further investigation in the COVID-19 environment compared with about 70% who would have been investigated further in routine practice. Practical considerations to minimise risks are taken, including patients being asked to sit in scanners to minimise contact with the equipment. Patients are reassured that they will be seen as quickly as possible. Imaging for every patient with TIA/stroke is routinely reviewed by a multidisciplinary team to check against history, and this is continuing for virtual triage.

DOACs are prescribed unless contraindicated, with dosing based on patient-reported weight when a formal measurement is not available. Scripts are emailed to the nearest pharmacy.

A clinic letter is sent as usual and copied to the patient. This highlights that a full in-person examination was not possible. Patients are asked to contact the clinic secretary or GP referrer if symptoms have not improved in 1 month.

Case study 3: Oxford University Hospital referral system

Dr George Harston*, Consultant Physician, Acute General Medicine, Geratology and Stroke Medicine, Oxford University Hospital;* ***Professor Gary Ford****, Consultant Stroke Physician, Oxford University Hospitals NHS Foundation Trust*

The TIA and minor stroke referral pathway at Oxford University Hospitals NHSFT was reconfigured in 2019 when the TIA service switched to one delivered by the duty stroke consultant every day rather than via discrete outpatient clinics. The system has been further reconfigured to meet the challenges of the COVID-19 pandemic to minimise the amount of direct patient contact with the healthcare system.

To optimise the standard of triage, the TIA service referrals are reviewed directly by the duty stroke consultant throughout each day (at least twice per day) to ensure a prompt triage and clinic review service. The review process is supported in real-time by a dedicated TIA and stroke secretary. No referrals are made by telephone, unless the patient is already in the hospital and there is an opportunity to avoid a future visit to hospital from direct review by a member of the stroke team.

- Referrals from both the ED and GPs are completed using a referral proforma PDF sent to a dedicated nhs.net email address. Access to this TIA inbox is available to all of the stroke consultants and the TIA secretary.
- The referral proforma contains a structured template, check boxes to prompt appropriate referral, and information about alternative referral pathways for non-specialists. It also contains prompts to administer aspirin and give driving advice.
- The TIA inbox is reviewed by the duty stroke consultant at regular intervals throughout the working day to triage referrals for review or arrange alternative clinic arrangements. This permits opportunistic triaging around unpredictable acute care commitments.
- The TIA secretary also screens the TIA inbox to create virtual hospital encounters for each referral at the earliest opportunity. This ensures that a telephone review can be documented in the electronic health record at the time of triage and investigations requested against the correct patient encounter.
- Once an outcome for the referral is decided, the original referral email is forwarded to the same TIA inbox with 'Triaged:' prefixed in the email subject line and with instructions for the TIA secretary in the email body.
- A redirect rule has been created so the 'Triaged:' prefix ensures this forwarded email is automatically sent straight to a subfolder for actions and archive by the TIA secretary.
- The duty consultant can then delete the original referral email from the TIA inbox once all consultant actions are taken, ensuring it is clear to the next duty consultant which referrals have been reviewed and actioned.