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# Consensus statement on the interhospital transfer of patients with acute aortic syndrome: TRAVERSING Delphi study

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## ABSTRACT

**Background** Standardisation of referral pathways and the transfer of patients with acute aortic syndromes (AAS) to regional centres are recommended by NHS England in the Acute Aortic Dissection Toolkit. The aim of the Transfer of Thoracic Aortic Vascular Emergencies to Regional Specialist Institutes Group study was to establish an interdisciplinary consensus on the interhospital transfer of patients with AAS to specialist high-volume aortic centres.

**Methods** Consensus on the key aspects of interhospital transfer of patients with AAS was established using the Delphi method, in line with Conducting and Reporting of Delphi Studies guidelines. A national patient charity for aortic dissection was involved in the design of the Delphi study. Vascular and cardiothoracic surgeons, emergency physicians, interventional radiologists, cardiologists, intensivists and anaesthetists in the United Kingdom were invited to participate via their respective professional societies.

**Results** Three consecutive rounds of an electronic Delphi survey were completed by 212, 101 and 58 respondents, respectively. Using predefined consensus criteria, 60 out of 117 (51%) statements from the survey were included in the consensus statement. The study concluded that patients can be taken directly to a specialist aortic centre if they have typical symptoms of AAS on the background of known aortic disease or previous aortic intervention. Accepted patients should be transferred in a category 2 ambulance (response time <18 min), ideally accompanied by transfer-trained personnel or Adult Critical Care Transfer Services. A clear plan should be agreed in case of a cardiac arrest occurring during the transfer. Patients should reach the aortic centre within 4 hours of the initial referral from their local hospital.

**Conclusions** This consensus statement is the first set of national interdisciplinary recommendations on the interhospital transfer of patients with AAS. Its implementation is likely to contribute to safer and more standardised emergency referral pathways to regional high-volume specialist aortic units.

## INTRODUCTION

Acute aortic syndrome (AAS) represents a group of life-threatening aortic emergencies including

### WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Diagnosis, initial management and transfer of patients with acute aortic syndromes (AAS) is often delayed. The Acute Aortic Toolkit, developed by NHS England, outlined seven principles aimed at optimising care of patients diagnosed with acute aortic dissection.

### WHAT THIS STUDY ADDS

⇒ Using the Delphi process, this study resulted in an interdisciplinary consensus statement on the key aspects of initial investigation, referral pathway and safe patient transfer to specialist aortic centres providing definitive management of patients with AAS.

### HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This consensus statement will be shared broadly to explore the potential for national adoption and subsequent clinical audit of the suggested pathway.

acute aortic dissection, intramural haematoma and penetrating aortic ulcer. Acute aortic dissection is the most common form of AAS, accounting for up to 95% of cases.<sup>1</sup> In the United Kingdom, it is estimated to affect 3900 people each year, with the number of cases forecast to double by 2050, due to the growing and ageing population, in addition to improved access to imaging.<sup>2</sup> Patients managed in high-volume regional aortic centres have been shown to have significantly lower operative mortality compared with those treated in local hospitals, resulting in centralisation of aortic services globally.<sup>3–6</sup> However, current evidence from the Healthcare Safety Investigation Branch report reviewing transfer of critically ill patients suggests that delays in diagnosis, initial management, processing and transfer of patients are a significant national problem.<sup>7</sup> In particular, some 50% of patients presenting with type A aortic dissection die before arriving at a specialist aortic centre.<sup>7</sup> The report also highlighted systemic issues surrounding rapid assessment, early diagnosis and



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prompt referral of patients with AAS. A key recommendation of the report was provision of an interdisciplinary guideline on the diagnosis and management of patients presenting to emergency departments with acute aortic dissection. The Royal College of Emergency Medicine and the Royal College of Radiologists responded to the report by publishing joint best practice guidance on the diagnosis of thoracic aortic dissection in emergency departments in November 2021.<sup>8</sup>

In line with the recommendations, NHS England published the Acute Aortic Dissection Toolkit in March 2022.<sup>9</sup> This document outlined seven principles designed to optimise the quality of care for patients once a diagnosis of acute aortic dissection has been made, providing guidance on regional governance, coordination through a regional multidisciplinary team, regional rota with single point of contact, timely and reliable image transfer, safe transfer, specialist treatment for all acute aortic dissections and running a regional education programme.

The Toolkit was subsequently endorsed by the Vascular Society of Great Britain and Ireland, the Society for Cardiothoracic Surgery in Great Britain and Ireland, the British Cardiovascular Intervention Society, the British Society of Interventional Radiology and the Aortic Dissection Charitable Trust.<sup>10–13</sup> The toolkit did not, however, explore initial assessment and the diagnostic pathway of patients presenting with AAS.

The global patient-led THINK AORTA campaign<sup>14</sup> has highlighted the problem of delayed diagnosis and transfer of AAS patients. Prompt recognition and management of these patients in emergency departments has also been recognised as one of the top 10 research priorities in the recently published James Lind Alliance Emergency Medicine Priority Setting Partnership refresh.<sup>15</sup>

In the United Kingdom, following the centralisation of aortic services, some regional centres implemented care pathways for patients presenting with AAS.<sup>16 17</sup> Nonetheless, such local protocols provided variable level of guidance on the specific aspects of the referral and interhospital patient transfer processes, potentially resulting in variation in clinical practice across the United Kingdom. Involvement of the key stakeholder groups such as emergency physicians, vascular and cardiothoracic surgeons, interventional radiologists, cardiologists, anaesthetists and intensivists from across the United Kingdom in this study allowed for the development of a balanced consensus statement on the optimum patient transfer conditions.

The aim of the Transfer of Thoracic Aortic Vascular Emergencies to Regional Specialist Institutes Group (TRAVERSING) study was to establish interdisciplinary consensus on the initial investigations, preferred diagnostic imaging, referral pathway and interhospital transfer arrangements for patients with AAS.

## METHODS

This study used Delphi methodology<sup>18</sup> in line with Conducting and Reporting of Delphi Studies guidelines.<sup>19</sup> The Delphi method aims to establish consensus on expert opinions by delivering a series of anonymously completed structured questionnaires, commonly referred to as rounds. Responses to each round are fed back to the expert participants summarising their individual responses in relation to the overall group consensus. The items which individual participants may have previously considered unimportant are highlighted, allowing them to reconsider their initial responses. The Delphi survey rounds are continued until consensus is reached or the number of responses to subsequent rounds markedly decreases. There is no unified definition of a

significant decrease in the response rate, but most Delphi studies have two or three rounds.

## Ethics approval

No ethics approval required.

## Patient and public involvement

The study was conceived in response to a problem highlighted by the national patient charity for aortic dissection and the global, patient-led, THINK AORTA initiative.<sup>14</sup> The chair of the charity and leader of the THINK AORTA campaign is a member of the study steering committee. The best way to transfer AAS patients to specialist centres was cited as a research priority at the UK Department of Health National AAS Research Workshop in 2020, which was commissioned by the Secretary of State for Health in direct response to patient advocacy. Input and approval of the national patient charity was sought and obtained at every stage of the study. A patient representative attended all study meetings and reviewed and contributed to all documents. Prompt assessment and management of patients with AAS presenting to emergency departments in the United Kingdom has also been recognised as one of the top 10 research priorities by both patients and clinicians in the recent James Lind Alliance Emergency Medicine Priority Setting Partnership refresh.<sup>15</sup> Study results will be disseminated by the national patient charity and the global THINK AORTA campaign.

## TRAVERSING steering committee

A steering committee was formed of the key stakeholders involved in the diagnosis, transfer and definitive management of patients with AAS in the United Kingdom. It included 17 healthcare professionals representing emergency physicians, vascular and cardiothoracic surgeons, interventional radiologists, anaesthetists, intensive care physicians and patient representatives. Using their expertise, the steering committee designed the content of the Delphi survey to capture the essential aspects of the initial assessment, investigations, referral and transfer process to the regional aortic centres defined as centres providing definitive management for AAS.

## Delphi survey

### Survey design

A Delphi survey was designed using the Research Electronic Data Capture (REDCap) platform, hosted by the University of Bristol. It is a secure internet-based application used for creation and delivery of online questionnaires.<sup>20</sup> The survey was composed of 19 question stems, resulting in 117 individual statements addressing the key aspects of initial patient assessment, essential diagnostic imaging, referral pathway to the specialist aortic centre, interhospital transfer arrangements, required resources at the receiving, specialist aortic centre and the expected timeframes during the care pathway (online supplemental table 1). Each statement was rated using a 4-point Likert scale, with 1 corresponding to strong disagreement and 4 indicating strong agreement with the specific recommendation. In studies such as ours where neutral responses are deemed to be unhelpful in addressing specific objectives, Delphi studies using 4-point Likert scales have been previously demonstrated to be effective.<sup>21</sup> Furthermore, the use of 4-point Likert scale has been shown to result in a similar proportion of items reaching consensus criteria compared with studies using a nine-point Likert scale.<sup>22</sup> Prior to completing the first round of the survey, participants were asked

to specify their clinical specialty, grade, years in clinical practice and the specialist services available at their hospital.

### Survey distribution

An anonymised link to the first round of the Delphi survey was distributed to United Kingdom healthcare professionals through the mailing lists of their key, relevant professional societies and clinical networks, including the Vascular Society of Great Britain and Ireland, British Society of Interventional Radiology, British Society of Endovascular Therapy, Adult Critical Care Operational Delivery Networks, Adult Critical Care Transfer Services (ACCTS), Royal College of Emergency Medicine Safety Leads, Aortic Dissection Awareness UK and Ireland and the Rouleaux Club of Great Britain and Ireland. The steering committee adopted a pragmatic approach and opted to consider all the invited professionals as experts given their active role in delivering care to patients presenting with AAS.

Completed first round questionnaires were screened for duplicates and if the same individual submitted more than one survey, only the one with the greatest proportion of answered questions was included in the analysis. A personalised link to the subsequent rounds of the survey was sent out to those who completed the previous round. Participants were able to see their individual answers in relation to the overall group responses, providing an opportunity to reconsider their responses to help reach consensus. Given that the survey was designed as a set of 19 question stems with variable number of individual statements for ranking, all 117 statements were carried over to subsequent rounds to provide study participants more context when reconsidering their responses. Duplicate responses to the subsequent rounds were not possible as links were personalised and only one response per participant was allowed. The initial invitation email to round 2 and 3 was followed by two additional reminder emails to non-responders. The total number of Delphi rounds was determined by achievement of consensus or marked decrease in number of responses rendering the subsequent rounds impractical.

### Consensus criteria

Consensus criteria were determined prior to commencement of the first round of the Delphi survey and were adopted from previously published Delphi studies using 4-point Likert scale.<sup>23 24</sup> Statements ranked as either 'agree' or 'strongly agree' by more than 70% of respondents were included in the consensus statement. Similarly, statements ranked as either 'disagree' or 'strongly disagree' by more than 70% of participants were excluded from the consensus statement. No consensus was reached for statements not meeting these criteria. Statements not meeting these criteria were defined as not meeting consensus.

### Consensus meeting

A virtual consensus meeting attended by the TRAVERSING steering committee members was held after completion of the final Delphi survey round, similar to other studies.<sup>25</sup> During the meeting, 19 question stems from the survey were categorised into seven domains covered in detail in the consensus statement. The consensus statement was based on the results of the final Delphi round using the predefined consensus criteria. The steering committee members facilitated interpretation of the Delphi results in the clinical context and provided expertise on the feasibility of implementing and embedding the recommendations in routine practice.

**Table 1** Demographics of survey respondents

	Round 1	Round 2	Round 3
Number of responses	212	101	58
Fully completed	150 (71%)	88 (87%)	54 (93%)
Partially completed	62 (29%)	13 (13%)	4 (7%)
Specialty			
Vascular surgery	57 (27%)	32 (32%)	23 (40%)
Emergency medicine	64 (30%)	29 (29%)	18 (31%)
Cardiothoracic surgery	8 (4%)	5 (5%)	1 (2%)
Interventional radiology	24 (11%)	9 (9%)	5 (9%)
Cardiology	11 (5%)	8 (8%)	4 (7%)
Intensive care medicine	30 (14%)	9 (9%)	5 (9%)
Anaesthetics	18 (8%)	9 (9%)	2 (3%)
Grade			
Registrar	30 (14%)	10 (10%)	5 (9%)
Staff grade	6 (3%)	2 (2%)	1 (2%)
Consultant	176 (83%)	89 (88%)	52 (90%)
Years in clinical practice			
<5	13 (6%)	2 (2%)	1 (2%)
5–10	38 (18%)	14 (14%)	10 (17%)
11–20	90 (42%)	42 (42%)	18 (31%)
>20	71 (33%)	43 (43%)	29 (50%)
Services on site			
Cardiothoracic surgery	99 (47%)	50 (50%)	27 (47%)
Vascular surgery	158 (75%)	75 (74%)	44 (76%)
Interventional radiology	166 (78%)	76 (75%)	46 (79%)
Cardiology	179 (84%)	87 (86%)	51 (88%)
Emergency department	193 (91%)	91 (90%)	52 (90%)

Values expressed as numbers (% of total number of participants).

## RESULTS

### Delphi survey

Three Delphi rounds were completed between 22 December 2021 and 15 July 2022. Given that the participating professional societies did not advertise the survey simultaneously, the first round was open for 10 weeks to ensure good representation across clinical disciplines. To maximise the response rate, the second round of the survey was accessible for 7 weeks but the third and final round questionnaire was only open for 4 weeks as the response rate did not improve (despite two reminder emails sent to non-respondents).

The three consecutive Delphi rounds were completed by 212, 101 and 58 healthcare professionals, respectively, resulting in 48% and 57% relative response rate among the eligible participants for rounds 2 and 3. Twelve duplicate responses to the first round questionnaire were excluded from analysis. The two main specialties represented in the survey were Vascular Surgery and Emergency Medicine (table 1). Over 80% of respondents were consultants and >75% of respondents had at least 11 years of clinical experience.

The level of agreement on the key aspects of the interhospital transfer of patients with AAS improved over the consecutive Delphi rounds. Out of 117 individual statements exploring initial assessment, acquisition of appropriate imaging, the referral pathway, transport mode and time targets during patient journey, only 15 statements (13%) lacked consensus at the end of the final round (table 2).

Statements on which consensus was reached in the third and final Delphi round are listed in table 3.

**Table 2** The level of agreement on statements included in the survey over consecutive Delphi rounds

	Round 1 (N (%))	Round 2 (N (%))	Round 3 (N (%))
Statements for inclusion	41 (35)	54 (46)	60 (51)
Statements for exclusion	25 (21)	36 (31)	42 (36)
No consensus	51 (44)	27 (23)	15 (13)

Statements for inclusion—strongly agree or agree by >70% of respondents;  
Statements for exclusion—strongly disagree or disagree by >70% of respondents;  
No consensus—statements not reaching the above criteria. Values expressed as numbers (% of total number of statements included in the survey).

### Consensus meeting

The virtual consensus meeting was attended by the TRAVERSING steering committee members. The 19 question stems from the Delphi survey were categorised into seven domains covering:

1. Referral pathway.
2. Referral criteria to a specialist aortic centre.
3. Investigations required prior to interhospital transfer.
4. Arrangements for transfer.
5. Clinical management during transfer.
6. Resources required at the receiving specialist aortic centre.
7. Key time frames.

The consensus statement on the interhospital transfer of patients with AAS is shown in [box 1](#). The recommendations for each domain were based on the results of the third and final round of the Delphi survey as detailed in [table 3](#).

The steering committee also helped interpret the Delphi results in the clinical context. It was suggested that specialists managing complex aortic conditions should provide their high-risk patients with information that would enable their direct transfer to the specialist aortic centre in the event of an emergency. Furthermore, to avoid unnecessary radiation, if CT of the whole aorta is the first imaging of choice and clearly demonstrates aortic pathology, repeating the CT scan with ECG-gating is not warranted prior to hospital transfer. In cases where a patient is not accepted for transfer, the specialist from the aortic centre should be available to discuss the diagnosis and management plan with the patient and their family using the available telemedicine resources. Based on previous clinical experience, patients should be given anxiolytic medication in addition to adequate analgesia. Finally, transfer to the specialist aortic centre may still occur even if some resources (such as a specialist bed) are unavailable, especially if prompt interhospital transfer is in the patients' best clinical interests (such as a dissection requiring emergency surgery).

### DISCUSSION

The TRAVERSING Delphi study has used an interdisciplinary panel to establish consensus on the transfer of patients with confirmed AAS from diagnosis until their arrival at the specialist centre providing definitive management for the UK. The results include recommendations for personnel making and receiving and transferring referrals to specialist centre, criteria for referral, pretransfer investigations, management en route and criteria for a specialist centre to accept a referral and timing.

We recommend these guidelines be combined with the NHS England Acute Aortic Dissection Toolkit to ensure evidence-based modification of health services on a national level. The formal timeframes described in the care pathway could be used as national audit standards by regional aortic services

potentially emphasising the key barriers to implementation of these guidelines.

The time to reach an accurate diagnosis and initiating the referral process may be impacted by the available resources, especially during out of hours shifts. First, the involvement of senior clinicians in the interhospital discussions is likely to add further pressure on emergency medicine registrars and consultants, particularly in the context of unprecedented waiting times in emergency departments across the country.<sup>26</sup> Second, to comply with the key timeframes described in the care pathway, CT scans would need to be organised and reported promptly. This will result in additional pressure on radiology departments and specialist vascular radiology IR teams, which have already faced a 51.7% increase in the number of CT scans being performed nationally between 2013 and 2021.<sup>27</sup> Therefore, pathways and protocols for both in-hours and out-of-hours imaging will need to be developed in collaboration with local and regional radiology hubs and local specialist vascular interventional radiology centres.

Furthermore, the results of this Delphi study suggest that patients should ideally be transferred with support from appropriately trained healthcare professionals. While prompt transfer with this support may be achievable in larger centres, smaller district general hospitals usually have a limited number of doctors, nurses and allied healthcare professionals on duty out-of-hours, potentially compromising their capacity for timely interhospital transfers. Most acute aortic dissection patients fall within the scope of ACCTS and these pose an attractive alternative resulting in a high-quality patient care during interhospital transfer. At the time of publication, there is varied provision of ACCTS as some services are still in development, although full 24/7/365 provision is expected in the next 1–2 years.

The TRAVERSING Delphi study also showed support for the possibility of selected patients to be taken directly to specialist aortic centres if the diagnosis of AAS is thought to be highly likely. Nonetheless, the proposed primary triage by prehospital services to the aortic centre rather than local hospital requires appropriate systems and processes within ambulance services as well as agreements with regional specialist centres. Further work, including additional relevant expertise from prehospital clinicians, would be needed for this to be implemented into routine practice. Clear protocols would need to be developed to provide clinical care for patients if AAS was excluded, in order to sustain appropriate patient flow in specialist care services. These protocols should ideally describe what support would be provided from other specialities in the specialist centre and allow for timely repatriation of patients without AAS to local hospitals for further management, after any necessary initial treatment or exclusion of other life-threatening conditions.

Ultimately, given the dynamic nature of AAS, safe patient care will rely on timely, effective communication between the referring hospital and the specialist centre. Patient-centred discussions, particularly with respect to possible deterioration, including cardiac arrest, and the delivery of palliative care should involve the patient, their relatives, local teams and aortic specialists.

The recommendations highlighted in the consensus statement generated by our study are in line with previously published local guidelines on the interfacility transfers of patients with AAS in the USA. The protocol implemented by the Minneapolis Heart Institute Foundation, a regional American aortic centre in Minnesota, suggested that patients with suspected or confirmed AAS should undergo CT angiogram of the aorta and have a full set of blood tests (including cross-match) completed prior to referral to the specialist centre. The specialist centre accepting transfers is expected to ensure the availability of the operating theatre and team.<sup>28</sup> While these guidelines do not provide clear indication on the expected timeframes during the transfer process, Medicare data from the USA suggests that most patients reach the specialist centre within 2 hours,<sup>3</sup>

**Table 3** List of statements reaching consensus in the third and final Delphi round

Statement	Proportion of respondents in agreement (%)		
	Round 1	Round 2	Round 3
Who should make the referral to the specialist aortic centre:			
Registrar or equivalent	87	90	91
Consultant	82	80	85
Registrar or equivalent should receive the call and arrange admission at the aortic centre	92	92	93
Patient may bypass the nearest hospital (non-aortic centre) and be taken directly to the aortic centre if:			
Aortic centre has an emergency department	58	66	81
Patient has typical new symptoms suggesting acute aortic syndrome and pre-existing aortic disease	72	79	84
Patient has typical new symptoms suggesting acute aortic syndrome and has had previous aortic intervention	75	86	91
Criteria required prior to considering transfer:			
Assessing clinician considers symptoms and signs of acute aortic syndrome are likely/possible	63	74	83
Pre-existing aortic disease with typical new symptoms suggesting acute aortic syndrome	67	81	88
Known pregnancy and typical new symptoms suggesting acute aortic syndrome	61	74	86
CT scan of whole aorta	88	98	95
CT scan of whole aorta reported by a radiologist	69	87	84
There is no age limit at which transfer for acute aortic syndrome would be inappropriate—always discuss with the aortic centre	81	85	96
Transfer to the aortic centre would be appropriate for patients with:			
No or minimal systemic disease	94	99	100
Moderate systemic disease	93	98	98
Severe systemic disease	48	52	72
Transfer to the aortic centre would be appropriate for patients who:			
Are independent	88	100	100
Need some help with daily living	90	96	98
Require institutional care for mental illness	58	67	80
Always discuss with aortic centre	70	81	91
What patient condition would be appropriate for transfer:			
Alert and talking	96	100	100
Obedying commands	94	99	100
Fluctuating consciousness	88	92	95
Shock requiring ongoing intervention	71	76	85
Unconscious/intubated	69	74	86
Which investigations should be completed in the initial assessment of a patient with confirmed acute aortic syndrome:			
Full blood count	75	85	92
Urea and electrolytes	76	87	96
Cross-match	66	81	89
Arterial or venous blood gas measurement	80	93	98
ECG	92	98	100
CT scan of the whole aorta	88	98	96
Which treatments are reasonable to expect during transfer:			
Analgesia	96	100	100
Blood pressure support (pharmacological or intravenous fluids)	87	96	98
Blood pressure reduction (pharmacological)	87	93	98
Blood transfusion	61	72	78
Airway should be managed with appropriate expertise (including ability to intubate if required)	79	84	91
What patient monitoring should be reasonably expected during transfer:			
Intermittent vital sign monitoring (pulse, blood pressure, temperature, saturations, respiratory rate, conscious level)	75	87	93
Continuous vital sign monitoring	83	98	95
What if a patient had a cardiac arrest during transfer:			
Manage as per basic life support (BLS) principles	61	69	78
Manage as per advanced life support principles (as BLS plus airway/drugs/defibrillation if indicated)	76	82	93
Manage as per the discussion with the aortic centre* that occurred prior to transfer	84	93	92
How should the patient be transferred:			
Category 1 Ambulance—life-threatening ( $\leq 7$ min response time)	82	95	98
Category 2 Ambulance—time critical ( $\leq 18$ min mean response time)	69	87	87
Adult Critical Care Transfer Service	67	76	81
What would be an appropriate skill mix for transfer:			

Continued

Table 3 Continued

Statement	Proportion of respondents in agreement (%)		
	Round 1	Round 2	Round 3
Paramedics and nurse	48	61	74
Paramedics and doctor	67	75	80
Transfer-trained nurse	65	81	85
Transfer-trained doctor	74	81	86
Adult Critical Care Transfer Service	72	87	91
What facilities should be available prior to transfer at the aortic centre:			
ED resuscitation bed	60	70	78
Access to CT scan and radiologist	84	92	92
Access to ECG gated CT scan	47	59	75
Emergency endovascular facility with 24/7 on call team (including IR consultant)	81	92	93
Operating theatre	83	93	95
Operating theatre with enhanced imaging facilities and ability to perform endovascular interventions	74	84	83
What should be the time frame for referral following diagnosis:			
Less than 30 min	89	96	100
30–60 min	76	83	95
What should be the time frame for agreed patient transfer commencing following diagnosis:			
Less than 30 min	83	94	95
30–60 min	87	92	94
What should be the time frame for arrival at the aortic centre following diagnosis:			
30–60 min	80	90	89
1–4 hours	65	77	81

The proportion of respondents in agreement has been shown for each round and was defined the proportion of participants in either agreement or strong agreement with a given recommendation. Rounds 1, 2 and 3 were completed by 212, 101 and 58 individuals, respectively. Adult Critical Care Transfer Service was defined as high-quality consultant-led care, co-ordination, triage and decision-support throughout the referral and transfer process between hospitals for all critically ill patients.

supporting our recommendations. Nonetheless, our healthcare systems are markedly different, and these timescales are not directly comparable.

### Limitations

Despite following the guidance on conducting and reporting Delphi studies,<sup>17</sup> our study has several limitations. First, the survey participants were healthcare professionals practising medicine in the National Health Service in the United Kingdom. Thus, generalisability of the study findings is likely to be limited to similar healthcare structures. However, the study was conducted in partnership with the global THINK AORTA initiative, which seeks to management of AAS around the world. Our findings in respect of the initial investigations, choice of diagnostic imaging and the principles of clinical management during the interhospital transfer will be adopted by THINK AORTA but may require some adaptation according to local healthcare resources and settings.

Second, despite having significant input in the management of AAS,<sup>29</sup> cardiothoracic surgeons and cardiologists were significantly underrepresented in the study, with only 2% and 7%, respectively, of the total number of the third and final round participants practising these specialties. Also, as all respondents were doctors, views of other experienced healthcare professionals have not been captured. Nonetheless, transfer services were represented by the Lead Consultant for Retrieve ACCTS and the National Critical Care Transfer Lead for NHS England. As Delphi Studies are designed to be completed by experts, it was decided that to ensure the right balance between inclusivity and appropriate level of expertise, only healthcare professionals were invited to respond to the Delphi. The patient charity was consulted during the development of the questionnaire and interpretation of the results.

To analyse the pathway more comprehensively than has been done before, the survey was composed of a considerable number of questions. As a result, the response rate of the consecutive Delphi rounds was moderate, with 48% and 57% relative response rate among the eligible participants for rounds 2 and 3, respectively. Low response rates are, however, a recognised limitation of Delphi studies, which have many items in the questionnaires.<sup>30</sup> Despite the decreasing number of respondents over the course of the study, the proportion of statements reaching consensus steadily improved. This could represent attrition bias due to possible self-selection of a specific subgroup of healthcare professionals providing continuous contribution to the study. Furthermore, the significant reduction in the number of participants across Delphi rounds necessitated termination of the Delphi study after round 3, despite lack of consensus on 15 out of 117 (13%) of the statements.

### Conclusions

The TRAVERSING Delphi study is the first national interdisciplinary consensus study, which clarifies the principles of transfer of patients with AAS to specialist high-volume aortic centres in the United Kingdom. Implementation of the consensus statement in routine clinical practice is likely to standardise and optimise the quality of care provided to patients with acute aortic pathologies on a national level.

### Dissemination of results

The consensus statement will be shared with the specialist societies whose members contributed to the Delphi. We will approach relevant groups to explore national adoption of the study results and subsequent clinical audit of the suggested pathway. The national patient charity Aortic Dissection Awareness UK & Ireland will also

### Box 1 Consensus statement for interhospital transfer of patients with acute aortic syndrome to specialist aortic centres providing definitive management.

#### Transfer of Thoracic Aortic Vascular Emergencies to Regional Specialist Institutes

##### Referral pathway

- ⇒ Referral to a specialist aortic centre\* should be made by a registrar-level clinician or above.
- ⇒ Clinician receiving the referral and arranging admission at a specialist aortic centre should be a registrar-level clinician or above.
- ⇒ Patient may bypass the nearest hospital and be taken directly to the specialist aortic centre only if the specialist aortic centre has an emergency department.
  - ⇒ the patient has typical new symptoms suggesting AAS on background of either:
    - ⇒ pre-existing aortic disease or
    - ⇒ previous aortic intervention.
  - ⇒ the case has been remotely discussed with a senior emergency physician at the local hospital, which was the original destination for the patient.
- ⇒ Specialists managing aortic conditions are encouraged to provide high-risk patients with a pass allowing them for direct transfer to the specialist aortic centre in case of an emergency.

##### Criteria warranting referral to a specialist aortic centre

Patients should be referred to a specialist aortic centre if any of the following conditions are met:

- ⇒ Referral to a specialist aortic centre can be made without diagnostic imaging (although not necessarily warranting transfer) if the:
  - ⇒ assessing clinician considers symptoms and signs of AAS likely
  - ⇒ patient has typical new symptoms suggesting AAS on a background of either:
    - ⇒ pre-existing aortic disease or
    - ⇒ current pregnancy
- ⇒ CT scan of whole aorta in keeping with AAS as interpreted by a clinician with experience of viewing aortic imaging
  - ⇒ ECG gated CT scan of whole aorta is preferable but only if readily available without causing a delay in the referral pathway.
    - ⇒ If CT scan of the whole aorta demonstrates acute aortic pathology, an ECG gated CT scan is not warranted.
- ⇒ Echocardiogram or ultrasound scan suggestive of AAS performed by an experienced person, in addition to typical new symptoms, may be helpful but only if available and not causing a delay in the referral process.

##### Additional comments:

- ⇒ All patients with AAS should be discussed with the specialist aortic centre irrespective of age and functional status
  - ⇒ Patients with circulatory collapse should also be discussed, even if they are unlikely to survive an intervention and transfer may not be in their best interest.
- ⇒ A clinician from the specialist aortic centre should ideally be available to discuss the diagnosis and reasons for local management with the patient and their family over the phone or equivalent.

Continued

### Box 1 Continued

- ⇒ If a patient is accepted for transfer by the specialist aortic centre, there should be a clear plan agreed in case of a cardiac arrest occurring during the interhospital transfer.

##### Required investigations prior to the interhospital transfer

- ⇒ Patients accepted for transfer to the specialist aortic centre should have the following investigations completed:
  - ⇒ Full blood count.
  - ⇒ Renal profile.
  - ⇒ Arterial or venous blood gas.
  - ⇒ Cross-match (only if blood transfusion is necessary during transfer).
  - ⇒ ECG.
  - ⇒ CT scan of whole aorta.

##### Interhospital transfer arrangements

- ⇒ Patients should be transferred to a specialist aortic centre in a category 2 ambulance (time critical conditions, £ 18 minutes response time).
- ⇒ Patients should be accompanied by either a nurse or a doctor (ideally transfer-trained) to ensure that therapeutic infusions can be given if required.
- ⇒ The patient should be referred to the local Adult Critical Care Transfer Service\*\*, if available.

##### Clinical management during the interhospital transfer

- ⇒ Depending on the clinical picture, patients being transferred to a specialist aortic centre are expected to receive:
  - ⇒ adequate analgesia and anxiolytics
  - ⇒ blood pressure support or reduction
  - ⇒ blood transfusion if required
- ⇒ Airway complications need to be considered prior to transfer and should be managed by a clinician with appropriate expertise (including intubation if required).
- ⇒ During the transfer patients should have either intermittent or continuous vital sign monitoring. Invasive arterial or central venous pressure monitoring is not required.
- ⇒ In the event of a cardiac arrest, patients should be managed as per Basic Life Support or Advanced Life Support principles depending on the skillset of the transferring team.
  - ⇒ The management of a cardiac arrest during transfer should be agreed prior to transfer.

##### Required resources at a specialist aortic centre prior to commencing transfer

- ⇒ The specialist aortic centre should confirm availability of the following facilities prior to commencement of an interhospital transfer:
  - ⇒ resuscitation or Critical Care bed (level 2 or 3 as appropriate).
  - ⇒ access to CT scan (including ECG-gated CT scan) and a specialist vascular interventional radiologist.
  - ⇒ emergency endovascular facility with 24/7 on call team including cardiothoracic surgery, interventional radiology and vascular surgery and relevant allied professionals, including nursing staff and radiographers.
  - ⇒ operating theatre with enhanced imaging facilities and ability to perform endovascular interventions (hybrid operating theatre).
- ⇒ Transfer may, however, occur without these resources being available if prompt transfer is in patient's best interests.

Continued

## Box 1 Continued

## Key time frames

⇒ From the time of diagnosis:

- ⇒ referral to a specialist aortic centre should be made within 1 hour.
- ⇒ transfer to a specialist aortic centre should be commenced within 2 hours.
- ⇒ the patient should arrive at a specialist aortic centre within 4 hours (however, this will be dictated by the local geographic variation and access to emergency patient transfer services).

\*Specialist aortic centre defined as a centre that can provide definitive management of patient with all acute aortic syndromes

\*\*Adult Critical Care Transfer Services are commissioned by NHS England to deliver high-quality consultant-led care throughout referral and transfer process for all critically ill patients requiring transfer between hospitals. They are operating or in development in all regions of England.

disseminate the consensus statement and champion its adoption by using it to set expectations of an improved standard of care for patients with AAS.

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