

Why you should read this article:

- To recognise that parents of infants who undergo cardiac surgery need preparation for home discharge
- To familiarise yourself with the Congenital Heart Assessment Tool (CHAT), a parental early warning tool
- To read about an e-learning resource designed to enhance the use of the CHAT by healthcare professionals

Enhancing discharge preparation for parents after complex cardiac surgery: evaluation of an e-learning resource for nurses

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Citation

Gaskin K, Daniels A (2024) Enhancing discharge preparation for parents after complex cardiac surgery: evaluation of an e-learning resource for nurses. *Nursing Children and Young People*. doi: 10.7748/ncyp.2024.e1515

Peer review

This article has been subject to open peer review and checked for plagiarism using automated software

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Conflict of interest

None declared

Accepted

11 January 2024

Published online

July 2024

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Abstract

Parents need to be appropriately prepared by knowledgeable healthcare professionals before going home with their infant following cardiac surgery for complex congenital heart disease (CHD). A quality improvement project was undertaken between 2018 and 2021 to equip healthcare professionals including children's cardiac nurses with the knowledge required to use the Congenital Heart Assessment Tool (CHAT) to teach parents how to monitor their infant at home. The project involved developing, implementing and evaluating an e-learning resource that included simulated scenarios captured on video. An online survey showed that users perceived the e-learning resource as having a positive effect on their understanding of complex CHD and their practice of preparing parents for discharge and home monitoring.

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Keywords

carers, child health, clinical, education, e-learning, families, infants, neonatal, parents, patients, professional, simulation, surgical

Background

In 2020, congenital heart disease (CHD) was the most common birth defect in England (66.6 per 10,000), with 1,242 children born with severe cardiac defects (NHS Digital 2022). In 2021-2022, more than 3,000 cardiac surgical procedures were undertaken in children, including approximately 2,000 in infants (children under one year of age) (National Institute for Cardiovascular Outcomes Research 2024).

For some infants with complex CHD – for example, functionally univentricular hearts – several stages of surgery are required and the first year of life remains perilous. Infants who have undergone complex cardiac surgery are particularly vulnerable to sudden cardiac

events (Crowe et al 2016). Some centres discharge infants with a home monitoring programme between the first two stages of surgery, but this requires parents to be adequately prepared and empowered to care for their infant safely while they are at home (Gaskin et al 2023). It is vital that parents are able to recognise deterioration early and know who to contact for advice and support (Tregay et al 2016a, Brown and Smith 2018, Gaskin et al 2023). However, several studies have identified that parents are concerned that they may not be able to recognise deterioration in their infant (Twaddell 2013, Tregay et al 2016a, 2016b, Gaskin et al 2023).

A qualitative study by Gaskin et al (2016), using an online survey and a discussion

group, found that parents felt unprepared for going home with their infant after the first stage of complex cardiac surgery for a functionally univentricular heart and systemic shunt-dependent cardiac lesions. There were gaps in parents' understanding of the factors indicative of deterioration in their infant. Less than one third of mothers felt they understood everything about their infant's heart condition at the time of discharge. Furthermore, parents felt that local healthcare professionals were unprepared and needed to be educated about caring for an infant with CHD, particularly in an emergency (Gaskin et al 2016). This has also been identified by other authors, for example March (2017) and Wray et al (2018a).

Congenital Heart Assessment Tool

Based on the findings of their study, Gaskin et al (2016) developed a parental early warning traffic-light tool called the Congenital Heart Assessment Tool (CHAT), designed for parents of children coming home after first-stage cardiac surgery or cardiac intervention in the first year of life. The tool was tested in a feasibility study (Gaskin et al 2018).

The CHAT (Gaskin et al 2016) uses clinical indicators in green (low risk), amber (intermediate risk) and red (high risk) categories. The expected normal vital sign values can be individualised for each infant by their consultant. At least five days before discharge, parents are taught how to observe and assess their infant using the tool, what variations in their observations may mean, and the significance of indicators being in the green, amber or red column. Parents are taught that:

- » If all observations fall in the green column, everything is normal and no action is needed.
- » If any observation falls in the amber column, they must call the ward for advice.
- » If any observation falls in the red column, they must immediately call for an ambulance, since this indicates that their infant is likely to be seriously ill.

Parents are asked to assess their infant once a day, or more often if the infant's condition changes, and to record their observations in a diary which they are asked to bring to clinic appointments.

Updated version of the tool

A multicentre evaluation of the CHAT between 2016 and 2018 showed its usefulness in tertiary care settings and community settings for healthcare professionals and parents to escalate their concerns (Smith et al 2023).

Participants acknowledged that staff training was a necessity to ensure the successful implementation of the tool. Based on the evaluation's findings, an updated version of the tool, called CHAT2, was developed in 2019 with the aim of equipping healthcare professionals with the necessary knowledge, skills and understanding to prepare parents for going home with their infant after complex cardiac surgery and for using the CHAT2 to monitor their infant at home (Gaskin et al 2023).

Simultaneously, in 2019, a service evaluation was undertaken at the tertiary cardiac surgical centre where the CHAT had originally been developed and tested. The team at the centre, who had initially implemented the tool, had stopped using it because of concerns about workload. In the service evaluation, the nature and number of telephone calls made by parents of children with CHD to the centre were assessed and children's cardiac nurses' experiences of taking calls from parents were explored (Gaskin et al 2024, Menzies et al 2024). The evaluation of telephone calls from parents identified safety issues, with a quarter of calls related to significant clinical events or issues that required timely review and intervention (Menzies et al 2024). Participants suggested that safety could be improved by using a tool to structure communication, assessment, decision-making and documentation of parents' concerns. The authors' recommendations were to implement the CHAT2 and educate all healthcare professionals at the centre so that they would be equipped with the necessary knowledge to apply the tool in practice (Gaskin et al 2024).

A quality improvement project was undertaken to develop an e-learning resource that would provide consistent education on the use of the CHAT2 to healthcare professionals involved in caring for infants with complex CHD. This article reports on that quality improvement project, adhering to the revised Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0) (Ogrinc et al 2016).

Aim

The aim of the quality improvement project was to develop an e-learning resource that would equip children's cardiac nurses and other healthcare professionals with the necessary knowledge, skills and understanding to apply the CHAT2 when teaching parents how to monitor their infant at home and when taking calls from parents.

Key points

- Infants who have undergone complex cardiac surgery are vulnerable to sudden cardiac events
- Parents are often concerned that they may not recognise deterioration in their infant after cardiac surgery
- Parental education about monitoring their infant at home and communicating with healthcare professionals if their infant's condition changes is essential
- The Congenital Heart Assessment Tool (CHAT) is designed to equip healthcare professionals with the necessary knowledge to prepare parents for going home with their infant after complex cardiac surgery
- An e-learning resource has been developed to provide consistent education to healthcare professionals on how to use the CHAT to educate parents and respond to their concerns

Method

The quality improvement project was conducted between 2018 and 2021 at the tertiary cardiac surgical centre where the CHAT had originally been developed and tested, in collaboration with colleagues at the University of Worcester, using the plan, do, study, act (PDSA) model for improvement (NHS England and NHS Improvement 2021). The phases of the project were:

- » Plan: design and development of the e-learning resource – this involved meetings with stakeholders, design and content planning and the recording of videos for inclusion in the resource.
- » Do: implementation and dissemination of the e-learning resource – the e-learning resource was finalised, piloted, made available to students and made publicly available.
- » Study: evaluation of the e-learning resource – an online survey was developed and launched and data were collected and analysed.

» Act: implementation of the new CHAT2. Although this was a quality improvement project, the university to which the authors are affiliated expected ethical approval to be requested. Ethical approval was therefore sought and obtained from the University of Worcester College of Health, Life and Environmental Sciences research ethics panel (CHLES18190013).

The project was funded by the University of Worcester Learning, Teaching and Student Experience Fund (2017-2018), which focuses on funding opportunities to enhance students' employability, enterprise and entrepreneurship. Furthermore, the project was aligned to the aims of the Teaching Excellence Framework (Office for Students 2020) and Research Excellence Framework (Research Excellence Framework 2024), since it involved research-based and technology-enhanced learning and aimed to make a transformative contribution to the lives of the students, staff and people in the region.

Plan – Design and development

Designing and developing the CHAT2 e-learning resource involved a team of academics, students, clinicians, a learning technologist and representatives from Little Hearts Matter, a national CHD charity. The e-learning resource was designed considering different learning theories and styles (Bastable 2008) and using the principles of Bloom's Taxonomy (Armstrong 2010).

The learning objectives for the healthcare professionals using the e-learning resource were:

- » To enhance their knowledge and understanding of complex CHD so that they could teach parents how to spot signs of clinical deterioration in their infant at home.
- » To develop an understanding of the CHAT2, who it is for, what it does and why it is used.
- » To learn how to apply the CHAT2 when teaching parents before discharge.
- » To learn how to use the CHAT2 to support decision-making when taking telephone calls from parents.

The design team began by creating a framework for the content of the e-learning resource based on the learning objectives and a storyboard for each of the proposed videos. Clinical simulation methodology was used for the videos, with scenarios involving healthcare professionals and parents being role-played by the design team. Using simulation in the videos allowed to mimic the environmental, physical, social and psychological complexity of the clinical implementation of parent education before an infant's discharge home after first-stage cardiac surgery (LeBlanc et al 2011, Cheng et al 2014). The learning technologist recorded and edited the videos and supported the development of the e-learning resource.

Do – Implementation and dissemination

In the implementation and dissemination phase, the CHAT2 e-learning resource was piloted by three children's nursing and paramedicine students from the University of Worcester. Following the pilot, the final version was uploaded as a Sharable Content Object Reference Model (SCORM) package to modules in the University of Worcester virtual student learning environment. It was also made freely available, under a Creative Commons Attribution licence, via the website of the Congenital Cardiac Nurses Association (CCNA) – without a means to track the number of people accessing it. Additionally, all children's cardiac nurses at the tertiary cardiac surgical centre ($n=54$) were given a 7.5-hour study day to go through the e-learning resource between February 2020 and June 2021.

The e-learning resource was then more formally disseminated and publicised through the CCNA newsletters, on social media and at several national and international conferences. Its inclusion in academic modules has focused on midwifery and physician associate courses. Communication with leaders of other courses, notably in children's nursing, advanced nursing

practice and paramedicine, is ongoing to bring the e-learning resource to their attention.

In December 2021, the project team was contacted by Health Education England (HEE) for permission to include the e-learning resource on page 25 of the cardiovascular diseases training resources guide (HEE 2022). Since 2022 the e-learning resource has also been available via e-learning for healthcare.

Study – Evaluation

An online survey was developed to evaluate the knowledge mobilisation occurring among learners freely accessing the CHAT2 e-learning resource. Specific objectives were to:

- » Identify which professional groups were accessing the e-learning resource and their geographical location, to map the use of the CHAT2 across the UK – and potentially internationally.
- » Identify how users had heard about the e-learning resource and why they had accessed it, to ascertain whether this was part of a planned implementation in their entire cardiac network or for individual professional development.
- » Ascertain how users had accessed the e-learning resource – for example on a laptop, desktop, tablet or smartphone – to gather information about ease of access, usability and effectiveness.
- » Ascertain whether the e-learning resource had met users' learning needs and whether any improvements were required.
- » Ascertain whether using the e-learning resource had led, or would lead, to changes in users' behaviour and/or practice.

The authors developed a questionnaire encompassing quantitative and qualitative questions. The three children's nursing and paramedicine students who had been involved in piloting the CHAT2 e-learning resource also piloted the questionnaire, keeping in mind ease of access, speed and convenience. The final version of the questionnaire was designed and disseminated as an online survey. The first question asked respondents to provide consent, and they had to respond to be able to continue.

A total of 98 responses to the survey were received between February 2020 and July 2022. Descriptive statistical analysis of the quantitative data was undertaken and the qualitative data were thematically analysed following Braun and Clarke's (2006) principles.

Respondents included nurses ($n=49$), paediatric cardiology consultants ($n=2$)

and students ($n=39$). A large majority of respondents were from Birmingham ($n=53$) or Worcestershire ($n=39$), but four respondents were from other parts of the UK, from Canada and from China. Table 1 shows respondents' demographics.

All respondents agreed that the e-learning resource clearly explained what they were expected to learn. The e-learning resource took varying amounts of time to complete, the shortest being 25 minutes and the longest nine hours (mean 3.4 hours, standard deviation 2.3). About half of all respondents ($n=50$, 51%) indicated that using the e-learning resource would lead to a change in their behaviour and/or practice and 13 (13%) said that using the e-learning resource would not; 35 (36%) did not answer that question.

Table 1. Respondents' demographics ($n=98$)

Professional role	Band 5 nurse	34 (35%)
	Band 6 nurse	11 (11%)
	Band 7 nurse	4 (4%)
	Paediatric cardiology consultant	2 (2%)
	Student	39 (40%)
	Other	8 (8%)
Location	Birmingham	53 (54%)
	Worcestershire	39 (40%)
	Oxford	1 (1%)
	Newcastle	1 (1%)
	Canada	1 (1%)
	China	1 (1%)
	Unknown	2 (2%)
	Found out about the CHAT2* e-learning resource through:	Word of mouth
Cardiac network		36 (37%)
Email		23 (23%)
Lecturer/course material		26 (27%)
Accessed the CHAT2 e-learning resource via:	Laptop or desktop computer	80 (82%)
	Smartphone or tablet	11 (11%)
	No answer	7 (7%)

*CHAT2: updated version of the Congenital Heart Assessment Tool

Figure 1 shows respondents' views on the accessibility, usability and effectiveness of the e-learning resource and Figure 2 shows respondents' perceptions of the relevance of each e-learning resource section (learning outcome) for learning. Not all 98 respondents answered all questions.

Further analysis of data revealed four themes about the effects of using the e-learning resource on awareness, behaviour and practice:

- » Parental education and improving parents' confidence.
- » Structuring telephone conversations with parents.

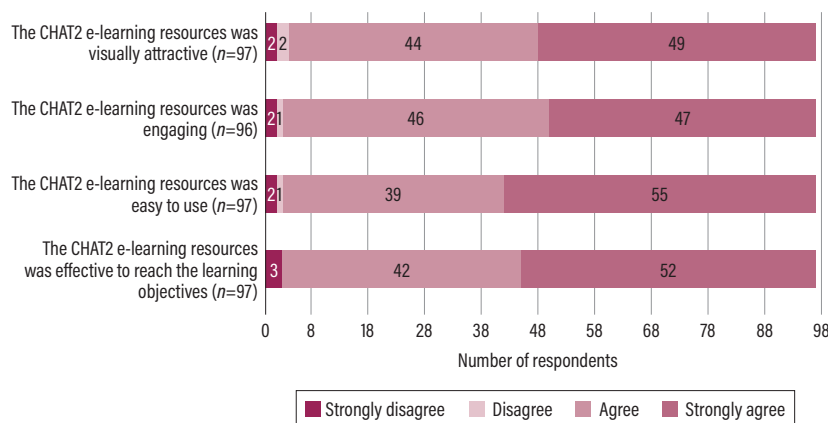
» Enhancing one's knowledge and understanding.

» Implementing the CHAT2.

Table 2 contains participant quotes illustrating each of these four themes.

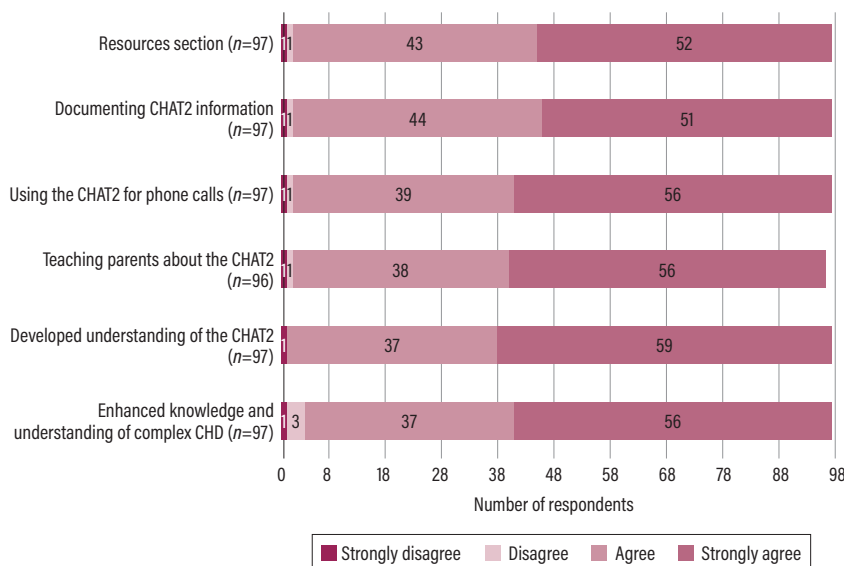
The benefits of the CHAT2 e-learning resource included: the visual resources and simulation videos; learning at one's own pace; structure, organisation and content; and improved knowledge. Limitations included the inability to access some of the articles mentioned and being given too much information. Although the e-learning resource had been developed to allow users to revisit it at any time and skip to the section where they had left off, some respondents found that this functionality was not working. Table 3 contains participant quotes illustrating the benefits and limitations of the e-learning resource.

Figure 1. Accessibility, usability and effectiveness of the CHAT2* e-learning resource



*CHAT2: updated version of the Congenital Heart Assessment Tool

Figure 2. Perceived relevance of each CHAT2* e-learning resource section (learning outcome) for learning



*CHAT2: updated version of the Congenital Heart Assessment Tool; CHD: congenital heart disease

Act – Implementation of the updated tool

The CHAT2 e-learning resource was made available to all healthcare professionals at the tertiary cardiac surgical centre. In collaboration with the cardiac surgeons, cardiologists and nurse managers, a plan was developed to implement the updated CHAT2 (Gaskin et al 2023) at the centre in 2020. However, due to the coronavirus disease 2019 (COVID-19) pandemic, the implementation was postponed until June 2021. Since June 2021, the CHAT2 has been consistently used by healthcare professionals at the centre to prepare parents whose infant has undergone surgery for complex CHD for discharge and home monitoring. A service evaluation of the implementation of the CHAT2 between 2021 and 2023, including an exploration of the experiences of parents and staff, has recently been completed. The PDSA cycle is to be repeated to evaluate the effect of the implementation of the CHAT2.

Discussion

This quality improvement project was, to the best of the authors' knowledge, the first to specifically address the educational needs of children's cardiac nurses in terms of preparing parents for their infant's discharge after complex cardiac surgery. Published studies have focused on educational elements of family-centred care in the hospital setting, rather than on the transition from hospital to home.

Dean et al (2021) noted a lack of consistency in the implementation of family-centred developmental care at a cardiac

centre. Family-centred developmental care has emerged as a promising approach to support the neurodevelopment of infants with congenital heart defects during hospitalisation (Dean et al 2021). Dean et al (2021) undertook a clinical education project to increase children’s cardiac nurses’ understanding of that approach and reduce perceived barriers to its implementation. The education programme improved nurses’ understanding and supported the integration of developmental care interventions for infants (Dean et al 2021).

Shackleford et al (2023) explored nurses’ perceptions of a novel rooming-in programme at a paediatric cardiac acute care unit, whereby family caregivers of infants with complex CHD were allowed to stay at the hospital with their infant.

The rooming-in programme had been developed in response to a nurse-led evidence-based practice project on caregiver knowledge. It improved the involvement of caregivers in their infant’s care. While Shackleford et al (2023) did not report an educational programme, increased confidence among caregivers resulted in increased confidence and satisfaction among nurses. Using the teach-back method – asking caregivers to repeat what they had been told to check that they had understood the information – improved nurses’ confidence relating to how effectively they could teach caregivers vital skills before their infant’s discharge. Likewise, in the present project, respondents’ qualitative feedback indicated that using the e-learning resource had improved their knowledge, understanding and confidence for preparing parents for discharge.

Campbell (2015) recognised the challenges of developing and updating the knowledge and skills needed by children’s intensive care unit (PICU) nurses to care for infants with CHD after open-heart surgery. Campbell (2015) undertook a learning needs assessment of each nurse to individualise their education programme. Education included classroom and simulation learning activities, with complex scenarios developed for the most experienced nurses. Participants perceived simulation as a safe way to learn new skills as well as an opportunity to discuss concerns or fears. In the present project, respondents particularly liked the simulated scenarios shown in the videos, perceiving them to be beneficial in terms of learning how to teach parents to use the CHAT2 and in terms of managing phone calls from concerned parents.

The simulated scenarios captured on video demonstrated a consistent and effective approach to preparing parents for their infant’s discharge while showing participants how they could use the CHAT2 in practice.

A strength of the quality improvement project has been the inclusion of children’s nursing students in the design and development of the e-learning resource. The students had some understanding of parents’ experiences but little specialist cardiac knowledge, and were therefore able to approach the video storyboarding with a perspective different from that of other members of the design team. Furthermore, making the e-learning resource available to a variety of undergraduate and postgraduate healthcare students has contributed to their academic and professional development.

The CHAT2 e-learning resource has been accessed by healthcare professionals in geographical locations other than the region where it had been developed, including

FURTHER RESOURCES

Congenital Heart Assessment Tool e-learning resource for healthcare professionals <https://lttu.uk/External/CongenitalHeartAssessment/#/>

Congenital Heart Assessment Tool e-learning resource for parents <https://lttu.uk/External/CongenitalHeartAssessmentParents/#/>

Table 2. Effects of using the CHAT2* e-learning resource on awareness, behaviour and practice

Theme	Participant quotes
Parental education and improving parents’ confidence	<ul style="list-style-type: none"> » ‘Provide discharge advice early and allow parents to build their own confidence in assessing their baby.’ (Participant 9, nurse) » ‘This e-resource has made me think about parental anxiety and preparedness prior to discharge a lot more. It has helped me understand the importance of education and ensuring parents feel confident to go home with their child and when/how to ask for help.’ (Participant 16, nurse) » ‘I will be starting discharge conversations with parents much sooner.’ (Participant 33, nurse) » ‘It can be used as a guide to cover all aspects of what parents should look out for when caring for their child at home.’ (Participant 34, nurse)
Structuring telephone conversations with parents	<ul style="list-style-type: none"> » ‘Usually if parents ring, they give us a rough idea of what’s going on and symptoms. However, this tool also gives us some guidance [about] what to ask.’ (Participant 18, nurse) » ‘Ensuring I use relevant resources to pointer my advice. Will use the tool to guide assessment via telephone and advice to parent/carer.’ (Participant 28, nurse) » ‘By using the tool, I will be able to get a thorough history over the phone and be aware of what advice to give to parents.’ (Participant 50, nurse)
Enhancing one’s knowledge and understanding	<ul style="list-style-type: none"> » ‘More aware of different stages of deterioration.’ (Participant 19, nurse) » ‘Improve my ability to answer parents’ questions. Improve my underpinning knowledge of care. Improve advice I give to parents.’ (Participant 38, nurse) » ‘Being aware of signs and symptoms of congenital heart disease and what to do if this is suspected.’ (Participant 60, midwifery student) » ‘More knowledge, so will look out for those specific signs.’ (Participant 90, physician associate student)
Implementing the CHAT2	<ul style="list-style-type: none"> » ‘We will implement this in our region.’ (Participant 8, consultant) » ‘Will investigate potential use of this system.’ (Participant 25, consultant)

*CHAT2: updated version of the Congenital Heart Assessment Tool

overseas. This shows that the CHAT2 is being considered for implementation nationally and internationally, demonstrating that it could have a wider reach and effect on networks and collaborations.

Limitations

While the e-learning resource was made available to all healthcare professionals at the tertiary cardiac surgical centre where it had been developed, only the nurses at the centre were given study leave to complete it. Of the 98 respondents to the survey, 53 (54%) were from the tertiary cardiac surgical centre, and of these 53 respondents 47 were nurses. Nurses are the healthcare professionals who prepare parents for discharge with their infant, but calls from

parents may be taken by other healthcare professionals as well as by nurses.

The project team was initially unable to track the number of people accessing the e-learning resource, which meant that the survey’s response rate could not be calculated. The team has now identified a way to track access and this will be useful for ongoing evaluation.

Ongoing and future developments

Feedback from users is continually reviewed and acted on to improve the CHAT2 e-learning resource. The authors have developed a parental version of the e-learning resource and have made it available via the CCNA website. Further education of healthcare professionals will be needed to ensure consistency in parental preparation for discharge and home monitoring.

Further evaluation will be needed to assess parents’ perceptions of their preparation for discharge using the CHAT2. Future work could also include translating the CHAT2 for non-English speaking parents, since there is a high incidence of CHD among children from minority ethnic backgrounds (Knowles et al 2017) and language has been shown to be one of the barriers experienced by families during discharge planning (Wray et al 2018b).

Conclusion

When infants with CHD are discharged home after complex cardiac surgery, their parents need to have received education from knowledgeable healthcare professionals so that they are able to recognise deterioration early and know what to do if their infant’s condition changes.

The quality improvement project described in this article consisted of developing, implementing and evaluating an e-learning resource designed to support nurses and other healthcare professionals involved in the care of infants with CHD to use the CHAT2 to educate parents and respond to their concerns.

Respondents to the evaluation survey perceived the e-learning resource as having a positive effect on their understanding of CHD and on their practice of preparing parents for discharge and home monitoring of their infant after cardiac surgery.

The authors hope that the e-learning resource will contribute to enhance the practice of healthcare professionals, the care of infants and the experience of parents, including beyond the setting where it was developed.

Table 3. Benefits and limitations of the CHAT2* e-learning resource

Theme	Participant quotes
Visual resources and simulation videos	<ul style="list-style-type: none"> » 'I really enjoyed the simulation videos, especially the telephone conversation. Very informative and showed how easy the tool is to use.' (Participant 16, nurse) » 'I really like the use of the videos to demonstrate how the tool will be used.' (Participant 22, nurse) » 'I think the videos were really engaging and showed how the tool would be used in real life - teaching patients how to use it as well as receiving a phone call from a concerned patient.' (Participant 79, physician associate student)
Learning at one's own pace	<ul style="list-style-type: none"> » 'It's very good for me to quickly relook at sections at my own pace.' (Participant 5, nurse) » 'Gave an opportunity to refresh understanding on cardiac conditions and could come back to it when able to.' (Participant 50, nurse) » 'How it was laid out and structured to provide time to write notes and do the learning activities.' (Participant 61, nurse)
Structure, organisation and content	<ul style="list-style-type: none"> » 'Flowed nice and steady and I feel junior members of my team will be able to access it also.' (Participant 19, nurse) » 'Well organised, good resources, referenced.' (Participant 25, consultant) » 'The resources - especially the links to understanding anatomy etc of children with congenital heart disease.' (Participant 32, nurse) » 'Additional resources and materials to complement the easy-to-follow materials on the site.' (Participant 68, physician associate student)
Improved knowledge	<ul style="list-style-type: none"> » 'I think it is a great tool! Learnt a lot!' (Participant 8, consultant) » 'It gives you a refresher of congenital heart disease and other common conditions on the ward.' (Participant 17, nurse) » 'I feel much more confident in putting the dots together regarding my comprehension of congenital heart disease and hypoplastic right and left heart syndrome and shunts.' (Participant 70, physician associate student)
Limitations	<ul style="list-style-type: none"> » 'Article links that would not let me read the article without paying for a subscription.' (Participant 16, nurse) » 'Too much to listen to, difficult when working on a busy ward.' (Participant 32, nurse, band 6) » 'It took a long time to complete.' (Participant 50, junior nurse, band 5) » 'It doesn't save the progress if you need to turn your laptop off so had to do half of it all over again.' (Participant 65, student)

*CHAT2: updated version of the Congenital Heart Assessment Tool

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