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Taking acute medical imaging to the patient, the domiciliary based X-ray response team

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ABSTRACT
Objectives: In 2019 NHS England and NHS Improvement announced their strategy to safely reduce the number of patients who are unnecessarily conveyed into a hospital setting by 2023. The recent coronavirus pandemic emphasised the importance of reducing avoidable conveyance. Consequently, a multidisciplinary team consisting of a Paramedic, Radiographer and Emergency Care Clinician was created to respond to Category 3 and 4 calls to assess patients in their own home using an array of specialised diagnostic equipment including a lightweight portable X-ray unit supplied by Fujifilm, the FDR Xair. This team was named the X-ray response team (XRT).

Key findings: Over a 7-month period the team attended 54 calls, the majority of which were in the patient’s private residence (86%), the overall average age of the patients attended was 80 years. A patient survey found 100% of respondents rated the service as very good with 100% also feeling that they were treated with respect and dignity. The team reduced avoidable conveyance by 50% as 27 of the 54 patients were discharged on scene and kept at home.

Conclusion: Proof of concept was achieved. The XRT improved patient care and experience as patients were assessed and diagnosed in their home environment which also minimised the risk of contracting hospital acquired infections.

Implications for practice: The XRT reduced avoidable conveyance by 50% with 100% of the patient’s involved providing positive feedback. The team are exploring new pathways that would allow direct referral to specialist teams in the hospital such as care of the elderly and orthopaedics which would: improve patient experience, ease A&E pressures, reduce costs and make the most effective use of the resources available.

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Introduction
This technical note aims to outline the details of the X-ray response team (XRT), the reasons for its creation and how proof of concept was achieved.

Background
In 2019, the National Health Service Improvement (NHSI) and NHS England (NHSE) amalgamated with the objective of modernising the NHS into an innovative, efficient and financially stable healthcare system that provides safe and high-quality compassionate care.¹ A main aim of NHSE is to reduce avoidable hospital conveyance by 2023 however it is accepted that safely reducing avoidable conveyance is a systemwide responsibility and a multi-disciplinary team working approach is crucial to success.¹

The recent coronavirus pandemic emphasised the importance of reducing avoidable conveyance so that hospitals could retain capacity for the critically ill and minimise the risk of hospital acquired infections to vulnerable demographics.² Consequently, the Northumbria Radiology and Emergency Departments collaborated with the North East Ambulance Service (NEAS) to pilot a domiciliary based service called the X-ray Response Team (XRT). The team was only operational at weekends and relied upon the enthusiasm of volunteers.

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Table 1
Key performance data.

| Month, year | Total number of referrals | Total number of referrals stood down | Total number of referrals attended | Referrals requiring X-ray | Admissions to the local emergency care hospital | Admissions avoided |
|-------------|---------------------------|-------------------------------------|----------------------------------|--------------------------|-----------------------------------------------|-------------------|
| November, 2020 | 1                        | 0                                   | 1                               | 1                        | 1                                             | 0                 |
| December, 2020  | 9                        | 0                                   | 9                               | 9                        | 4                                             | 5                 |
| January, 2021   | 10                       | 1                                  | 9                               | 8                        | 6                                             | 3                 |
| February, 2021  | 5                        | 0                                  | 5                               | 4                        | 3                                             | 2                 |
| March, 2021     | 10                       | 1                                  | 9                               | 9                        | 5                                             | 4                 |
| April, 2021     | 9                        | 0                                  | 9                               | 9                        | 6                                             | 3                 |
| May, 2021       | 8                        | 0                                  | 8                               | 8                        | 2                                             | 6                 |
| June, 2021      | 4                        | 0                                  | 4                               | 4                        | 0                                             | 4                 |
| Total           | 56                       | 2                                  | 54                              | 52                       | 27                                            | 27                |

Figure 1. Radiographs performed.

Figure 2. Acute findings.
The X-ray response team

The XRT was made possible by the innovative portable X-ray unit supplied by Fujifilm, the FDR Xair. Prior to the FDR Xair, portable X-ray units were large cumbersome machines that required a power source and were logistically difficult to transport. In contrast, the FDR Xair is a highly transportable compact unit designed to be used outside of the hospital setting where a power source may not be available that only weighs 3.5 kg.

The team consisted of a senior Radiographer, Emergency Department (ED) Clinician and a specialist trauma/research Paramedic with a Pre-Hospital Emergency Medicine (PHEM) consultant providing oversight management remotely. The XRT functioned as a flat hierarchy although legal constraints dictated that certain roles were the responsibility of appropriately trained team members; the Radiographer was responsible for all radiation safety and the ED Clinician/Paramedic were responsible for the clinical assessment and prescription of analgesics.

The team responded to category 3 and 4 calls received by the ambulance service from private residences and care homes. Once on scene the team worked together to assess the patient and formulate a plan of action, these findings would then be discussed with the oversight management to decide if medical imaging and conveyance to hospital was required.

Challenges

The team worked closely with a Radiation Protection Advisor (RPA) and Medical Physics Expert (MPE) who facilitated the safe working of the equipment within the community. New local rules were created and the Health and Safety Executive (HSE) registration for the Trust was expanded to cover plain film imaging in the community to adhere to the Ionising Radiation Regulations (IRR) 2017.

The RPA made recommendations on reducing the risk of damage during transportation. This included a more durable case for the X-ray tube and shock detectors attached to the tube and carry cases. They also recommended a longer exposure button cable to reduce unnecessary dose to the operator. All community locations required a risk assessment that would be performed by the Radiographer after receiving Radiation Protection Supervisor (RPS) training. This included creating a controlled area, ensuring that the primary beam was directed at a solid floor or brick wall and maintaining a clear 2 m distance around the primary beam and patient. The MPE developed a daily QA schedule for the equipment which included a weekly lead shielding test that would also to be carried out in the event of a triggered shock detector.

Pelvic images routinely require the use of a secondary radiation grid to absorb scattered radiation however this necessitates a high milliampere-seconds (mAs) to produce diagnostic images. The FDR Xair does not have the capability to produce a high mAs due to its compact size and weight; the maximum output is 90 kV (kV) 2.5 mAs. Instead, pelvic radiographs were acquired using an average of 80 kV and 2 mAs with a virtual grid applied during post-processing which corrected the effects of scattered radiation, this produced diagnostic images of comparable detail and contrast to radiographs acquired in the hospital setting.

Patient feedback

Patient feedback was gathered on a tablet computer while the team were still on scene, this involved the patient or their carer completing an online questionnaire. We received feedback from 35 patients with 100% of them rating the service as very good and 100% felt they were treated with respect and dignity. All patients gave consent for their data to be included in this study.

Results

The pilot was in operation between November 2020 and June 2021 with 56 patients referred although 2 patients were deemed unsuitable and were therefore referred back to NEAS. The average age of the patients attended was 80 years with ages ranging from 69 to 91, 86% of these patients were assessed in their private residence with the remaining number assessed in care homes. Table 1 shows the number referrals received, how many required imaging and the number of admissions avoided. Fig. 1 demonstrates the number and type of radiographs performed whereas Fig. 2 demonstrates how many of the images showed acute pathology. The majority of acute findings involved fractures of the pelvis, hip and ankle and these patients were all conveyed to hospital. Some patients were still conveyed to hospital even though the radiograph showed no acute findings because of clinical findings such as breathing difficulties and mobility issues.

Future recommendations

The service should be expanded to operate full time which would require support and funding. Patient pathways should be developed so that patients assessed by the XRT could bypass ED and be referred directly to the appropriate service such as Orthopaedics or Care of the Elderly (COTE).

Conclusion

Proof on concept was achieved as the team reduced conveyance by 50%. This has cost saving implications as well as easing pressures on NEAS and ED. Patient care and experience was greatly improved as they were assessed in their own environment without the long waiting times associated with emergency care. Further-more, patients who were conveyed into hospital still benefited from the service as they received pain management on scene and most already had a diagnosis on arrival to hospital so they could be directed to the appropriate service thus streamlining their pathway.

The XRT has far reaching implications that if managed correctly could be a huge step towards modernising the NHS into a more coherent and financially efficient service that delivers safe and high-quality compassionate care.

Conflict of interest statement

None

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