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The Cheshire & Merseyside Collaborative Registrars On-Call Service; A Review of Safety and Efficiency

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Abstract

AIM: The Cheshire and Merseyside Collaborative is the largest registrar led on-call service in the UK. This study aims to assess its safety and efficiency based on discrepancy rates and time take to issue reports.

MATERIALS & MEHODS: All studies reported by the collaborative in a 4-week period were evaluated for discrepancy and the time taken to issue a report. These figures were compared against the Royal Collage of Radiologists (RCR)guidelines and a recent national audit of discrepancy rates. The time take to report was measured against the National Institute of Health and Clinical Excellence (NICE) and Trauma Audit Research Network (TARN) guidelines.

RESULTS: The overall discrepancy rates for the collaborative were 2.5% for minor discrepancies and 2.0% for major discrepancies which is within the RCR standard. The median time taken to issue a report was 30 minutes which is within the NICE and TARN 1-hour targets.

CONCLUSIONS: The Cheshire and Merseyside Collaborative on call service can be deemed a safe and efficient way of delivering an out-of-ours Radiology service.

Introduction

Demand for imaging in UK hospitals is constantly expanding [(1)] which brings with it the challenge of managing increasing out-of-hours reporting work load. This is either provided by the in-house Radiology team or outsourced to external companies. Those who choose to manage their own out-of-hours reporting often use a two-tier system consisting of a registrar taking referrals and issuing provisional reports with a consultant reviewing the images and issuing a final report [(2)]. Hospitals in the Cheshire and Merseyside region have expanded on this to create a collaborative on call which covers multiple hospitals.

The Cheshire and Merseyside Collaborative was set up in 2014 when the Royal Liverpool Hospital and Whiston Hospital combined their out-of-hours services. The driving force behind collaboration was the difficulty in maintaining a viable on-call service whilst adhering to the European Working Time Directive (EWTD). To ensure the registrar rota was compliant with the EWTD trainees would miss a large proportion of their normal departmental sessions due to rest days and therefore learning opportunities were reduced. Collaboration of two trusts meant more registrars on the rota, allowed the frequency of on-call shifts to be reduced and less training time missed.

The collaborative has grown since 2014 with the Countess of Chester Hospital joining most recently in August 2016. The Cheshire and Merseyside Collaborative now includes five acute hospitals (Arrowe Park, Chester, Royal Liverpool, Warrington and Whiston), one major trauma centre (Aintree) and a specialist cardiothoracic centre (Liverpool Heart & Chest).

The current system consists of four registrars per shift, three of which are based at a neutral "Hub" and one is based at region's major trauma centre. The most senior registrar (ST4 or above) is based at the Hub and acts as the shift leader. The registrars are responsible for taking referrals and issuing reports for all sites covered by the collaborative. Each site has its own on-call consultant who is available for advice, will review the reports for their individual hospital within 24 hours (usually the next morning) and add an addendum even if they completely agree with the report issued. The consultant is then responsible for informing trainees of major discrepancies and highlighting any specific concerns to the clinical tutors and consultant leads for the collaborative.

As the Hub is based away from the acute sites and the registrars are covering multiple hospitals, they only take referrals and issue reports for emergency CT examinations and will report X-rays if there is an urgent clinical need. The on-call consultant is responsible for reporting examinations left over from the day list and for urgent ultrasound, fluoroscopy and MRI requests. Requests for interventional procedures are dealt with differently in each hospital however advice is often given by the collaborative prior to discussion with the Interventional Radiology consultant.

As with any radiology service there is potential for discrepancy in the reports issued by the collaborative however, since its conception, only small local audits have been performed into the discrepancy rates. In 2017 two of the region's senior registrars established a regional learning forum (formerly discrepancy meeting) in which discrepancies and good spots from reports issued by the collaborative could be discussed in a blame-free environment. This has been well received by the local trainees and consultants with both discrepancies and good spots from the region featuring in the Royal Collage of Radiologist's (RCR) READ and

REAL magazines. Despite the success of the learning forum it is not a true reflection of the discrepancy rates of the collaborative as the meeting relies on consultants and trainees submitting cases for discussion.

In 2017 Howlett *et al* [3] published a large, multi-centre review of discrepancies in acute CT Abdomen examinations where they compared discrepancy rates between in-house consultant, registrar and out-sourced reports. They found that, of the registrar issued reports, the rate of major discrepancies was 4.6% and minor discrepancies was 8.4%. The RCR have also published guidance which suggests expected discrepancy rates of 2% (major) and 5% (minor) [4].

This audit aims to evaluate a larger sample of reports issued by The Cheshire and Merseyside Collaborative and compare these to the RCR standard and the results of the Howlett *et al* national audit (Table 1).

Standard	**Expected Discrepancy Rate**
RCR accepted rate of major discrepancies	2.0%
RCR accepted rate of minor discrepancies	5.0%
National audit expected rate of major discrepancies in Registrar reported CT Abdomen	4.6%
National audit expected rate of minor discrepancies in Registrar reported CT Abdomen	8.4%

Table 1: Summary of standards from the RCR and Howlett *et al* national audit to which we are measuring our results against.

In addition to issuing accurate reports, any acute reporting service should also be able to issue reports in a timely manner. There is currently no nationally accepted guideline as the to the time it should take to report CT examinations however the National Institute for Health and Care Excellence (NICE) suggest CT Head reports for suspected stroke be issued within one hour [(5)]. The Trauma Audit and Research Network (TARN) also suggest that formal reports for Whole-Body Trauma scans are issued within one hour [(6)]. The secondary aim of our study is to assess the efficiency of the collaborative by investigating the time take to issue reports using the NICE and TARN recommendations as a standard.

Materials & Methods

Data was collected from all scans reported by the Cheshire and Merseyside Collaborative over a 4-week period between 09/06/18 – 06/07/18.

The report issued by the registrar was compared with the addendum issued by the consultant and any discrepancy noted. If a discrepancy was identified the nature of the discrepancy was recorded. All discrepancies were then reviewed by a single reviewer (Cheshire & Merseyside Regional Registrar Discrepancy Lead: Author CMM) who was blinded to the name of the registrar issuing the report to prevent bias. The reviewer then graded the discrepancies as trivial (discounted), minor or major. Trivial discrepancies were those which had no bearing on the outcome of the patient either in the acute setting or beyond. Minor discrepancies were those which had no or minimal impact on the acute management of the patient. Major discrepancies were those with the potential to have immediate impact on the acute management of the patient or have the potential to cause significant harm in the long-term if not reported.

Data was also collected relating to the hospital, body part scanned, grade of registrar, time of scan acquisition and time of issuing report.

Data was collected using the Radiology Information Systems *CRIS* and *Carestream PACS*.

Results

In total 2571 scans were reported by the Cheshire and Merseyside Collaborative in the four-week period between 00:01 09/06/18 and 23:59 06/07/18. After discounting trivial discrepancies, a total of 114 discrepancies were identified, 63 of which were classified as minor and 51 as major (Table 2). This gives an overall discrepancy rate of 4.4% (2.5% minor and 2.0% major).

Trivial Discrepancies	Minor Discrepancies	Major Discrepancies
• Re-worded report with the same conclusion • VR errors (unless caused significant confusion) • Minor basal ganglia calcification • Minor mucosal sinus disease • Small scalp haematomas • Nasal bone fractures • Old rib fractures • Size insignificant pulmonary nodules • Small simple renal and hepatic cysts	• Undisplaced rib fractures • Small calcified meningioma (90 year old patient) • Overcall of pulmonary embolus (due to motion artefact) • Undisplaced skull fracture (reported bleed) • Increase in pulmonary nodule size (already under follow-up) • Non-obstructing 2 mm ureteric calculus • Overcall of pulmonary contusion (bilateral dependant changes) • Overcall of parafalcine subdural (was calcification)	• Small haemothorax in major trauma • Mesenteric fat stranding in major trauma • Diffuse sclerotic metastasis • Abdominal aortic aneurysm • Retroperitoneal haematoma in major trauma • Pulmonary embolus • Small acute subdural haematoma • Active GI bleed • Pneumothorax in major trauma • Spiculated lung lesion

Table 2: Examples of the discrepancies classified into the trivial, minor and major categories.

The discrepancy rates were then further categorised according to the specific body part scanned (Table 3). This categorisation demonstrated the lowest discrepancy rates in Head, Spine and Angiographic examinations (2.2%, 2.4% and 2.4% respectively) with the highest discrepancy rates in Chest and Whole-Body Trauma examinations (12.3% and 14.6% respectively).

Examination	Total	Total Discrepancy	% Minor Discrepancy	% Major Discrepancy
Head	1771	2.2% (39)	1.2% (21)	1.0% (18)
Spine	124	2.4% (3)	2.4% (3)	-
Chest/CTPA	81	12.3% (10)	4.9% (4)	7.4% (6)
Abdomen & Pelvis /KUB	328	11.0% (36)	5.8% (19)	5.2% (17)
Angiogram	82	2.4% (2)	2.4% (2)	-
Whole Body-Trauma	144	14.6% (21)	8.3% (12)	6.3% (9)
Other	41	7.3% (3)	4.9% (2)	2.4% (1)
TOTAL	**2571**	**4.4% (114)**	**2.5% (63)**	**2.0% (51)**

Table 3: Discrepancy rates categorised relating to specific body part scanned. The category "Angiogram" includes peripheral, carotid, intracranial and aortic angiograms. Mesenteric angiograms were grouped in the "Abdomen & Pelvis/KUB" category. "Other" includes musculoskeletal scans (CT Knee and CT Hips) CT Facial Bones and contrast enhanced CT neck.

The discrepancy rates were also categorised in relation to the grade of registrar reporting the scan (Table 4). This showed ST2 registrars to have the highest discrepancy rates at 4.9% and ST5 registrars to have the lowest discrepancy rates at 4.0%.

Grade of Registrar	Total Scans Reported	Overall Discrepancy Rate	Minor Discrepancy	Major Discrepancy
ST2	872	4.9% (43)	3.2% (28)	1.7% (15)
ST3	815	4.0% (33)	2.6 % (21)	1.5% (12)
ST4	581	4.5% (26)	1.6% (9)	2.9 % (17)
ST5	303	4.0% (12)	2.0% (6)	2.0% (6)

Table 4: Discrepancy rates split according to grade of specialist registrar reporting the scan.

Finally, the time taken to issue a report for all scans was calculated (Table 5). The median time taken to report any examination was 30 minutes. As CT Head and Whole-Body Trauma scans have target times published by NICE and TARN, average times for these examinations were also calculated with a median time taken to report Heads of 27 minutes and Whole-Body Trauma scans of 45 minutes.

Scan Type	Median time to report (minutes)
All Scans	30 (n=2571, range 1-383)
CT Head	27 (n=1771, range 1-196)
Trauma Pan-Scan	45 (n=144, range 13-192)

Table 5: Time taken for a report to be issued including specific data for CT Head and Whole-Body Trauma examinations.

Statistical Evaluation

Statistical analysis was applied to the overall discrepancy rate. The question posed was to assess whether the discrepancy rates were significantly above the RCR standards. Confidence intervals (CIs) were calculated based on a binomial distribution using the Agresti-Couli method [(7)]. This demonstrated no evidence that discrepancy rates were above the expected RCR levels. In fact, the overall discrepancy rate and the rate of minor discrepancies were significantly below the expected RCR levels. Overall discrepancy rate: Proportion=0.0443, Standard Error=0.0041 and 95% CIs of 0.0370-0.530. Minor discrepancy rate: Proportion=0.0245, Standard Error=0.0030 and 95% CIs of 0.0192-0.0312.

The second question posed for statistical analysis was whether there was a link between grade of registrar and the likelihood of discrepancy. A logistic regression method was used to

calculate the odds ratios based on grade of registrar relative to the ST2 group. Although the odds ratios for overall discrepancies was less than 1 in all groups (ST3=0.81, ST4=0.90 and ST5=0.80), when standard error was accounted for, none were significant enough using 95% CIs to suggest an association between registrar grade and likelihood of discrepancy. When the minor and major discrepancy groups were analysed there was a weak association between grade of registrar and minor discrepancies however again this was not significant using 95% CIs.

Discussion

The primary objective of our study was to investigate if the Cheshire and Merseyside Collaborative is providing a safe service using discrepancy rates as a marker. Overall discrepancy rates were within the expected RCR with 2.5% minor discrepancies and 2.0% major discrepancies (n=2571). As demonstrated in the statistical analysis section our data shows significantly lower rates of overall and minor discrepancies when compared to the RCR standards. This indicates that the collaborative is operating within the accepted levels to be deemed a safe service.

When the results were further categorised by the body part being scanned the discrepancy rates for CT Head, Spine, Angiogram and Other all fall within the RCR expected limits. Those for Chest/CTPA, Abdomen & Pelvis/KUB and Whole-Body Trauma scans fall outside of these expected ranges. As the RCR standards are not body-part specific it is not possible to make a direct comparison based on these figures however below we discuss the scans with the higher discrepancy rates and review the literature relating to these specific types of scan to make a more reasoned comparison.

The category with the highest discrepancy rate in our study was Whole-Body Trauma (WBT) scans. 144 WBTs were included with an overall discrepancy rate of 14.6% (8.3% minor and 6.3% major). These findings are not wholly unexpected as the literature looking specifically at WBTs suggests discrepancy rates of between 7-25% [8-10]. The reasoning behind such high discrepancy rates in this category is multifactorial with the complex nature of pathologies, multisystemic injuries, large data set, limited clinical information, satisfaction of search and time pressure being the most commonly reported [11-12]. We therefore have attempted to identify the main factors leading to discrepancies within this category in our study.

56% (n=4/9) of major discrepancies on WBTs in our study were made on scans with multisystemic injuries where the other findings were correctly reported. This suggests that satisfaction of search, the complex nature of the findings and the large data set are contributing factors. There was no theme of commonly missed findings which led to major discrepancies in this category. There was however a theme identified in the minor discrepancies with undisplaced rib fractures accounted for 58% (n=7/12). Anecdotally Radiologists are aware that undisplaced rib fractures are a common discrepancy and the literature supports this with studies reporting between 9-45% of rib fractures not being reported on initial CT [13-16]. Although undisplaced rib fractures rarely require intervention they are an important finding as they lead to increased morbidity in trauma patients [17]. On review of this sub-category of patients, none of those with missed undisplaced rib fractures had subsequent imaging suggesting they had undergone rib fixation. Evaluating each rib for acute injury is time consuming therefore time pressure is a key factor in missed rib fractures on WBTs. Limited clinical information was also identified as a contributing factor. On

review of the clinical information provided when a rib fracture was not reported, only 29% (n=2/7) specifically stated a concern for thoracic injury.

There is further evidence that the quality of clinical information is a contributing factor in discrepancies. In addition to the registrar's initial report and review by the on-call consultant, the major trauma centre in our study performs a third read of all WBTs in the form of a daily Multidisciplinary Team Meeting (MDT). The Radiologist is able to review the imaging with more detailed clinical information and the trauma team can express specific areas of concern for more detailed review after the tertiary survey has been completed. Additional findings on the third read accounted for 33% (n=7/21) of discrepancies in our study.

Chest CT was the category with the next highest discrepancy rate in our study which included 81 scans giving an overall discrepancy rate of 12.3% (4.9% minor and 7.4% major). The sample size in this category is particularly low so it is difficult to suggest this is representative of overall practice. Although the rate of major discrepancies appears high it is within the typical ranges reported in the literature which varies between 0.4-10% [18-20]. On review of these scans, undisplaced rib fractures accounted for 20% (n=2/10) of discrepancies. Pulmonary nodules, however, accounted for 50% (n=5/10) of the discrepancies with two being over-called as significant lesions, two being under-called in patients with known malignancy and one spiculated lesion not being reported. This mixture of over-calling and under-calling pulmonary nodules suggests a lack of knowledge relating to pulmonary nodule management therefore this is an area which has been identified to target future teaching. CT Chests only account for 3.2% of the total number of scans reported by the collaborative therefore inexperience is a contributing factor leading to higher discrepancy rates. A larger

study focusing specifically on out-of-hours CT Chests at the collaborative is currently being designed to further identify learning needs.

The final category to be above the RCR's expected discrepancy rate was CT Abdomen & Pelvis/KUB. This category included 328 scans with an overall discrepancy rate of 11.0% (5.8% minor and 5.2% major). The rate of major discrepancies is also above the national average for registrars of 4.6% reported by Howlett *et al*. As the overall discrepancy rate across all scans fell below the RCR's expected level and the relatively large sample size in this category it was unexpected that the discrepancy rates for abdomen and pelvis scans to be higher than the reported national average. We therefore compared the methodology of the Howlett *et al* study with our own to identify any contributing factors and found that our methodology differed in various ways. Firstly, there were differences in the inclusion criteria between the studies meaning the sub-category of scans being compared is different. Our inclusion criteria were less stringent therefore both CT KUBs and scans in the setting of trauma were included in our study. More importantly the Howlett *et al* methodology states that; *"For any given case the questionnaires only allowed the auditor to select a single and representative major/minor diagnosis"*, meaning only discrepancies in the primary diagnosis were included in their study. In comparison, our study considered all discrepancies in both the primary diagnosis and incidental findings. If we were to disregard those discrepancies not directly related to the primary diagnosis then the discrepancy rate in the CT Abdomen & Pelvis/KUB category would be 4.9% (2.1% minor and 2.7% major) which is below the national average (Table 6). On review of the discrepancies in this category there was no recurring theme identified on which to focus future teaching.

Standard	Target Rate	Collaborative Rate
RCR accepted rate of major discrepancies	2.0%	2.0%
RCR accepted rate of minor discrepancies	5.0%	2.5%
National audit expected rate of major discrepancies of Registrar reported CT Abdomens	4.6%	2.7%
National audit expected rate of minor discrepancies of Registrar reported CT Abdomens	8.4%	2.1%

Table 6: Summary of overall discrepancy rates compared to the RCR standard and discrepancy rates of the primary diagnosis only in CT Abdomen & Pelvis when compared to the Howlett *et al* national audit.

The discrepancies identified were also categorised by the grade of registrar who reported the scan (Table 4). Although the discrepancy rate of the ST2 group is higher than that of the more senior registrars there is no statistically significant difference in discrepancy rates between the ST2 to ST5 groups when odds ratios were calculated and 95% CIs applied which is in line with other studies [(21)]. These figures do not account for scans which the junior has discussed with the shift leader prior to issuing a report therefore the discrepancy rates in the junior group may be falsely low however, if this were the case, it helps prove that the collaborative system has a positive effect on patient safety. Table 5 does suggest that the number of scans reported decreases as the registrar become more senior. Although the reporting numbers for individual registrars were not measured this is thought to be due to higher numbers of junior registrars on the collaborative rota. This is explained by the RCR increasing numbers of training posts each year leading to larger intakes and senior registrars leaving the collaborative rota to join specialist rotas during their fellowships (such as Neuroradiology, Paediatrics and Interventional Radiology).

There are limitations in our study design relating to discrepancy rates. A discrepancy was recorded when the consultant addendum disagreed with the registrar's initial report which

assumes the consultant's interpretation is correct. As the collaborative covers multiple sites, it was not possible to access the clinical notes, laparotomy findings, biopsy results and subsequent imaging to prove the consultant's interpretation was indeed correct. This lack of clinical follow-up also led to a more significant limitation meaning that assessing potential and actual harm caused was difficult. Of the major discrepancies identified in our study 21 had the potential to cause harm when not reported in the acute setting. Of these 21, the consultant addendum specifically mentioned the patient was being managed conservatively in 9 cases therefore no actual harm was caused however no information was available for the other 11 patients. If we were to assume the worst-case scenario that all 11 patients came to harm then 0.4% of all patients scanned were harmed which is slightly lower than rates reported in similar studies [(22)]. Future studies would be required to make a more accurate assessment of harm caused.

Another limitation is that the study was conducted over a set period of four weeks which gave a good representative overview of workload and scan mix however meant some categories of less frequently performed scans had low numbers for evaluation. Further investigation is required into these categories, particularly CT Chests.

The secondary objective of our study was to investigate if the Cheshire and Merseyside Collaborative is providing an efficient service. To do this we calculated the time taken between the final image of a scan being acquired and a formal report being issued (Table 5). Initially the mean time was used however, in the time period covered by our study, the major trauma centre declared a major incident, during which verbal reports were issued and the time taken for a formal report to be verified was significantly higher than is typical. To account for these outliers, it was decided that median time would provide a more realistic representation

of reporting times. The overall median time taken to issue a report by the collaborative was 30 minutes (range 1-383 minutes) which is in line with the literature [23] and similar to the reporting time of 25 minutes from a leading teleradiology company within the UK in 2018 [24].

As the maximum reporting time was over 6 hours there are outliers within our results. Our data set broadly followed a Gaussian-like distribution therefore a standard deviation method was used to determine significant outliers. When a limit of four standard deviations from the mean was applied, only 0.86% (n=23/2571) of scans took longer than this limit to report. Of these, 9 occurred during the above described major incident, 7 recorded issues with image transfer and in the remaining 7 no explanation was documented.

NICE guidelines recommend that reports for acute stroke are issued within one hour therefore we used this as a target time for all CT Heads. The median time taken to report CT Heads was 27 minutes (range 1-196 minutes) with 89% of all CT Head reports being issued within the one-hour limit. Reporting times and compliance are similar to those quoted in the literature with reporting times ranging from 13-29 minutes and compliance with the one-hour target between 65-91% [25-27].

TARN guidelines also recommend that WBTs are formally reported within a one-hour time period. The median time taken to issue a WBT report was 45 minutes (range 13-192 minutes) with 73% being issued within the one-hour target. When compared to the literature this is within the expected ranges with reporting times ranging from 57-86 minutes and between 37-75% of formal reports being issued within one hour [10 & 28-31].

There are limitations within our study relating to the time taken to issue a report. The collaborative Hub is based remotely away from the acute sites where scans are acquired therefore relies on images being sent via a network. The time this takes varies depending on the number of images acquired. Our study defined "time to report" as the time from the final image being acquired to the report being verified and therefore did not account for delays in image transfer. It was not possible to determine the time at which images were available to be reported on Radiology Information System (RIS). On a similar theme, when the report is verified on RIS this must then be sent via the network to the hospitals Patient Information System. Again, it was not possible to determine when the report was available to be viewed by the clinical team or when the clinical team read the report.

Conclusion

Overall the Cheshire and Merseyside Collaborative is providing a safe and efficient service with discrepancy rates within the RCRs expected levels and the average time taken to report scans of 30 minutes.

Conflicts of Interest

The authors declare no conflicts of interest.

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