

Chapter 8 GP access to radiology

Emergency and acute medical care in over 16s: service delivery and organisation

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8 Primary care access to radiology

8.1 Introduction

Diagnostic radiology plays an important role in the diagnosis and management of patients presenting with an acute medical emergency (AME). This can range from simple imaging, such as plain film radiology- chest x-ray or abdominal x-ray, to more specialist tests such as computerised tomography (CT), magnetic resonance imaging (MRI), and ultrasound (US) imaging. There is a strategic drive in the United Kingdom to reduce emergency referrals to hospitals; however, the role of such investigations both in terms of access and same day reporting in a GP setting remains unclear.

While it may be accepted that more specialist tests should be restricted to a hospital setting, there may be a more specific role for plain film radiology, for example, in patients presenting to a GP with a sub-acute breathing problem such as a chest infection, exacerbation of chronic obstructive airways disease or exacerbation of asthma, the role of plain film radiology and reassurance of a normal chest x-ray may avoid unnecessary referral to hospital.

8.2 Review question: Does GP access to radiology with same day results improve outcomes?

For full details see review protocol in Appendix A.

Table 1: PICO characteristics of review question

Population	Adults and young people (16 years and over) with a suspected or confirmed AME or at risk of an AME.
Intervention	GP access to same day radiological investigations (plain film and ultrasound) with same day results.
Comparison	GP access to radiology (plain film and ultrasound) without same day results.
Outcomes	<ul style="list-style-type: none"> • Mortality (CRITICAL) • Avoidable adverse events (including delay in diagnosis and treatment, misdiagnosis) (CRITICAL) • Quality of life (CRITICAL) • Patient and/or carer satisfaction (CRITICAL) • Lab or Diagnostic turn around for result to GP (IMPORTANT) • ED attendance (CRITICAL) • Admissions (CRITICAL)
Study design	Systematic reviews (SRs) of RCTs, RCTs, observational studies only to be included if no relevant SRs or RCTs are identified.

8.3 Clinical evidence

No relevant clinical studies comparing GP access to same day radiological investigations with same day results to GP access to radiology without same day results were identified.

8.4 Economic evidence

Published literature

No relevant economic evaluations were identified.

- 1 See also the economic article selection flow chart in Appendix C.
- 2 The unit costs of GP visits, diagnostic tests and relevant hospital admissions or stays were presented
- 3 to the committee (see Chapter 41 Appendix I).

4 **8.5 Evidence statements**

5 **Clinical**

- 6 • No evidence identified.

7 **Economic**

- 8 • No evidence identified.
- 9
- 10

1 8.6 Recommendations and link to evidence

Recommendation	-
Research recommendation	RR5. What is the clinical and cost effectiveness of providing GPs with access to plain-film radiology or ultrasound with same day results?
Relative values of different outcomes	<p>The guideline committee considered 6 outcomes critical for inclusion in this review: mortality, avoidable adverse events, patient and/or carer satisfaction, quality of life, ED attendance and admission to hospital.</p> <p>The outcome laboratory/diagnostic turnaround for result to a GP was considered important.</p>
Trade-off between benefits and harms	<p>No evidence was identified which compared GP access to same day radiology or ultrasound results with not receiving results the same day. The committee discussed the absence of evidence and decided to develop a research recommendation.</p> <p>The committee noted that, although this is not current practice across the country, there was the potential for improvement in patient care and outcomes from the availability of same day plain film radiology and ultrasound for a specific subset of patients. It may lead to a decrease in ED admissions and earlier diagnosis. In turn, earlier diagnosis could mean quicker treatment and improved patient outcomes, including patient and/or carer satisfaction. Further research would be needed to evaluate this. This could include patients, such as those with asthma, presenting with acute chest pain and the need to rule out a small pneumothorax.</p> <p>The committee accepted that, in general, patients who might benefit from same day results from radiological investigations could be those who might also require specialist investigation or admission to hospital, as opposed to management within primary care; whilst patients with non-acute illness may not require radiology results on the same day.</p>
Trade-off between net effects and costs	<p>No relevant economic evaluations were identified. The unit costs of GP visits, diagnostic tests and relevant hospital admissions or stays were presented to the committee (see Chapter 41 Appendix I).</p> <p>Without effectiveness evidence, the committee were unable to assess the cost-effectiveness of same day results and therefore a research recommendation was made.</p>
Quality of evidence	<p>No evidence was identified which compared same day GP access to diagnostic radiology results compared to not receiving results on the same day. The committee discussed the absence of evidence and used consensus to develop a research recommendation.</p>
Other considerations	<p>The committee focused the research recommendation on plain film radiology and ultrasound as these investigations were most likely to be of benefit within the community. Ultrasound is included in this recommendation to reflect its growing use in rapid diagnosis, for example, to rule out a pleural effusion. The current approach is for GPs to refer patients to the ED or an AMU if they need same day plain film radiography or ultrasound.</p> <p>Patients would likely prefer rapid diagnosis and management to reduce uncertainty. It would be beneficial to patients to not have to transit through the emergency department to access investigations, particularly to those who are frail or elderly. The group decided not to include more invasive radiological investigations (such as CTPA) within the research recommendation as such patients would likely need specialist review and expert interpretation of results.</p> <p>The committee noted that there were likely to be logistical and staffing difficulties in the provision of same day plain film radiology and ultrasound results.</p>

Recommendation	-
Research recommendation	RR5. What is the clinical and cost effectiveness of providing GPs with access to plain-film radiology or ultrasound with same day results?
	The committee also noted that a 'result' was more than just the radiological images; expert interpretation would also be required for investigations which lay outside the expertise of individual GPs.

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References

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- 1 Apthorp LA, Daly CA, Morrison ID, Field S. Direct access MRI for general practitioners--influence on patient management. *Clinical Radiology*. 1998; 53(1):58-60
- 2 Benamore RE, Wright D, Britton I. Is primary care access to CT brain examinations effective? *Clinical Radiology*. 2005; 60(10):1083-1089
- 3 Blois B. Office-based ultrasound screening for abdominal aortic aneurysm. *Canadian Family Physician*. 2012; 58(3):e172-e178
- 4 Bui AAT, Taira RK, Goldman D, Dionisio JD, Aberle DR, El-Saden S et al. Effect of an imaging-based streamlined electronic healthcare process on quality and costs. *Academic Radiology*. 2004; 11(1):13-20
- 5 Bury B. The GP and the radiologist. *Practitioner*. 1987; 231(1425):259-261
- 6 Carey LS, O'Connor BD, Bach DB, Hobbs BB, Hutton LC, Lefcoe MS et al. Digital teleradiology: Seaforth--London network. *Canadian Association of Radiologists Journal*. 1989; 40(2):71-74
- 7 Castro AF, Silva-Turnes JC, Gonzalez F. Evaluation of retinal digital images by a general practitioner. *Telemedicine Journal and E-Health*. 2007; 13(3):287-292
- 8 Chan VSP, Piterman L, McCall L. Use of clinical ultrasonography in an Australian suburban family practice: its indications and findings. *Hong Kong Practitioner*. 1999; 21(9):405-415
- 9 Chaptini N, Dontaraju VS, Concepcion F, Muradi HA, Alyousef T, Del Pilar Aristizabal Canaval M et al. Ambulatory cardiac single-photon emission computed tomography at the primary care physician's office: a descriptive study. *Journal of Ambulatory Care Management*. 2010; 33(4):328-335
- 10 Collie DA, Sellar RJ, Steyn JP, Cull RE. The diagnostic yield of magnetic resonance imaging (MRI) of the brain and spine requested by general practitioners: comparison with hospital clinicians. *British Journal of General Practice*. 1999; 49(444):559-561
- 11 Detar JS. The family physician and the radiologist. *GP*. 1960; 22:145-148
- 12 Duncan JL, Wolf B, Nichols DM, Lindsay SM, Cairns J, Godden DJ. Screening for abdominal aortic aneurysm in a geographically isolated area. *British Journal of Surgery*. 2005; 92(8):984-988
- 13 Durham JA, McLeod DK. Use of diagnostic imaging services in the Central Region by general practitioners. *New Zealand Medical Journal*. 1999; 112(1090):233-236
- 14 Farrell TW. Survey into on-site radiology services in general practice. *Australian Family Physician*. 1977; 6(12):1585-1589
- 15 Fassiadis N, Roidl M, Stannett H, Andrews SM, South LM. Is screening of abdominal aortic aneurysm effective in a general practice setting? *International Angiology*. 2005; 24(2):185-188
- 16 Frohwein S, Chronos N. The use of electron beam computed tomography in the primary care setting. *Journal of the Medical Association of Georgia*. 2001; 90(4):23-26

- 1 17 Geary KG, Croft AM. Acute knee injuries in military personnel: a case-control study of the
2 effectiveness of direct-access magnetic resonance imaging in a primary care setting. *Military*
3 *Medicine*. 2007; 172(4):436-439
- 4 18 Gravil JH, Al-Rawas OA, Cotton MM, Flanigan U, Irwin A, Stevenson RD. Home treatment of
5 exacerbations of chronic obstructive pulmonary disease by an acute respiratory assessment
6 service. *The Lancet*. 1998; 351(9119):1853-1855
- 7 19 Guldbrandt LM, Fenger-Gron M, Rasmussen TR, Rasmussen F, Meldgaard P, Vedsted P. The effect
8 of direct access to CT scan in early lung cancer detection: an unblinded, cluster-randomised trial.
9 *BMC Cancer*. 2015; 15:934
- 10 20 Haber K. An introduction to B-scan ultrasonography. For the primary care physician. *Arizona*
11 *Medicine*. 1978; 35(5):322-326
- 12 21 Hahn RG, Davies TC, Rodney WM. Diagnostic ultrasound in general practice. *Family Practice*.
13 1988; 5(2):129-135
- 14 22 Halvorsen JG, Kunian A, Gjerdingen D, Connolly J, Koopmeiners M, Cesnik J et al. The
15 interpretation of office radiographs by family physicians. *Journal of Family Practice*. 1989;
16 28(4):426-432
- 17 23 Hammond DI. Some thoughts on primary care radiology. *Canadian Association of Radiologists*
18 *Journal*. 2000; 51(5):277-278
- 19 24 Hawksworth W, Allen EP. Radiological pelvimetry and the general practitioner. *Journal of*
20 *Obstetrics and Gynaecology of the British Empire*. 1951; 58(2):203-215
- 21 25 Howard L, Wessely S, Leese M, Page L, McCrone P, Husain K et al. Are investigations anxiolytic or
22 anxiogenic? A randomised controlled trial of neuroimaging to provide reassurance in chronic
23 daily headache. *Journal of Neurology, Neurosurgery and Psychiatry*. 2005; 76(11):1558-1564
- 24 26 Hussain P, Deshpande A, Shridhar P, Saini G, Kay D. The feasibility of telemedicine for the training
25 and supervision of general practitioners performing ultrasound examinations of patients with
26 urinary tract symptoms. *Journal of Telemedicine and Telecare*. 2004; 10(3):180-182
- 27 27 Hussain P, Melville D, Mannings R, Curry D, Kay D, Ford P. Evaluation of a training and diagnostic
28 ultrasound service for general practitioners using narrowband ISDN. *Journal of Telemedicine and*
29 *Telecare*. 1999; 5(Suppl 1):S95-S99
- 30 28 Ingeman ML, Ormstrup TE, Vedsted P. Direct-access to abdominal ultrasonic investigation from
31 general practice-the role in earlier cancer diagnosis. *Family Practice*. 2015; 32(2):205-210
- 32 29 Katerndahl DA. The primary care physician as ultrasonographer. *Postgraduate Medicine*. 1982;
33 71(5):191-196
- 34 30 Kiuru MJ, Paakkala TA, Kallio TT, Aalto J, Rajamaki M. Effect of teleradiology on the diagnosis,
35 treatment and prognosis of patients in a primary care centre. *Journal of Telemedicine and*
36 *Telecare*. 2002; 8(1):25-31
- 37 31 Kuritzky L, Haddy RI, Curry RWS. Interpretation of chest roentgenograms by primary care
38 physicians. *Southern Medical Journal*. 1987; 80(11):1347-1351

- 1 32 Laerum F, Eik-Nes S, Fonnebo V, Heilo A, Johnsen R, Stray-Pedersen B et al. Use of
2 ultrasonography in the primary health care setting, 2001
- 3 33 Lahde S, Jartti A, Broas M, Koivisto M, Syrjala H. HRCT findings in the lungs of primary care
4 patients with lower respiratory tract infection. *Acta Radiologica*. 2002; 43(2):159-163
- 5 34 Laine K, Maatta T, Varonen H, Makela M. Diagnosing acute maxillary sinusitis in primary care: a
6 comparison of ultrasound, clinical examination and radiography. *Rhinology*. 1998; 36(1):2-6
- 7 35 Laws C, Eastman J. Screening for abdominal aortic aneurysm by general practitioners and
8 practice-based ultrasonographers. *Journal of Medical Screening*. 2006; 13(3):160-161
- 9 36 Leiro-Fernandez V, Botana-Rial M, Tilve-Gomez A, Represas-Represas C, Pallares-Sanmartin A,
10 Fernandez-Villar A. Effectiveness of a protocolized system to alert pulmonologists of lung cancer
11 radiological suspicion. *Clinical and Translational Oncology*. 2014; 16(1):64-68
- 12 37 Li HK, Tang RA, Oschner K, Koplos C, Grady J, Crump WJ. Telemedicine screening of glaucoma.
13 *Telemedicine Journal*. 1999; 5(3):283-290
- 14 38 Li Y, Karnowski TP, Tobin KW, Giancardo L, Morris S, Sparrow SE et al. A health insurance
15 portability and accountability act-compliant ocular telehealth network for the remote diagnosis
16 and management of diabetic retinopathy. *Telemedicine Journal and E-Health*. 2011; 17(8):627-
17 634
- 18 39 Maurin O, De Regloix S, Lefort H, Delort G, Domanski L, Tourtier JP et al. French military general
19 practitioner: ultrasound practice. *Journal of the Royal Army Medical Corps*. 2014; 160(3):213-216
- 20 40 McLain PL, Kirkwood CR. The quality of emergency room radiograph interpretations. *Journal of*
21 *Family Practice*. 1985; 20(5):443-448
- 22 41 Merrington HN. On site radiology in general practice. The state of the art. *Australian Family*
23 *Physician*. 1981; 10(9):744-750
- 24 42 Miller G, Valenti L, Charles J. Use of diagnostic imaging in Australian general practice. *Australian*
25 *Family Physician*. 2006; 35(5):280-281
- 26 43 Mjolstad OC, Snare SR, Folkvord L, Helland F, Grimsmo A, Torp H et al. Assessment of left
27 ventricular function by GPs using pocket-sized ultrasound. *Family Practice*. 2012; 29(5):534-540
- 28 44 Morioka C, Dionisio JD, Bui A, El-Saden S, Kangaroo H. StructConsult: structured real-time wet
29 read consultation infrastructure to support patient care. *Studies in Health Technology and*
30 *Informatics*. 2007; 129(Pt 1):429-433
- 31 45 Olayiwola JN, Sobieraj DM, Kulowski K, St Hilaire D, Huang JJ. Improving diabetic retinopathy
32 screening through a statewide telemedicine program at a large federally qualified health center.
33 *Journal of Health Care for the Poor and Underserved*. 2011; 22(3):804-816
- 34 46 Osmond JDJ, DeMarco VJ, Farmer JP, King RL, Klein HJ, Storaasli JP et al. Radiology and the
35 primary care physician. *Ohio State Medical Journal*. 1977; 73(6):389-5
- 36 47 Oswald N. Chest x-rays and the GP. *Medical World*. 1964; 100:479-480
- 37 48 Oswald N. X-rays and the GP. *Medical World*. 1964; 100:198-201

- 1 49 Paakkala T. Training of general practitioners in interpreting chest radiographs. *Medical*
2 *Education*. 1988; 22(5):449-453
- 3 50 Pavlicek W, Zavalkovskiy B, Eversman WG. Performance and function of a high-speed multiple
4 star topology image management system at Mayo Clinic Scottsdale. *Journal of Digital Imaging*.
5 1999; 12(2 Suppl 1):168-174
- 6 51 Pickhardt PJ, Taylor AJ, Kim DH, Reichelderfer M, Gopal DV, Pfau PR. Screening for colorectal
7 neoplasia with CT colonography: initial experience from the 1st year of coverage by third-party
8 payers. *Radiology*. 2006; 241(2):417-425
- 9 52 Qureshi AI, Suri MF, Ali Z, Kim SH, Fessler RD, Ringer AJ et al. Role of conventional angiography in
10 evaluation of patients with carotid artery stenosis demonstrated by Doppler ultrasound in
11 general practice. *Stroke*. 2001; 32(10):2287-2291
- 12 53 Rawson MD. Accuracy in diagnosis of gastric and duodenal lesions by general practitioners,
13 hospital clinicians, and radiologists. *The Lancet*. 1965; 1(7387):698-699
- 14 54 Redmond P, Darker C, McDonnell M, O'Shea B. Establishing a general practitioner led minor
15 injury service: mixed methods evaluation at 10 months with an emphasis on use of radiology by
16 GPs in the out-of-hours setting. *Irish Journal of Medical Science*. 2013; 182(2):213-216
- 17 55 Rogers TK. Primary care radiography in the early diagnosis of lung cancer. *Cancer Imaging*. 2010;
18 10:73-76
- 19 56 Romero-Aroca P, Sagarra-Alamo R, Basora-Gallisa J, Basora-Gallisa T, Baget-Bernaldiz M,
20 Bautista-Perez A. Prospective comparison of two methods of screening for diabetic retinopathy
21 by nonmydriatic fundus camera. *Clinical Ophthalmology*. 2010; 4:1481-1488
- 22 57 Smith FC, Grimshaw GM, Paterson IS, Shearman CP, Hamer JD. Ultrasonographic screening for
23 abdominal aortic aneurysm in an urban community. *British Journal of Surgery*. 1993;
24 80(11):1406-1409
- 25 58 Speets AM, Hoes AW, van der Graaf Y, Kalmijn S, Sachs APE, Mali WPT. Chest radiography and
26 pneumonia in primary care: diagnostic yield and consequences for patient management.
27 *European Respiratory Journal*. 2006; 28(5):933-938
- 28 59 Stoddart PG, Holl SG. Radiology is valuable to general practitioners; but who pays? *Clinical*
29 *Radiology*. 1989; 40(2):183-185
- 30 60 Strasser RP, Bass MJ, Brennan M. The effect of an on-site radiology facility on radiologic
31 utilization in family practice. *Journal of Family Practice*. 1987; 24(6):619-623
- 32 61 Suramo I, Merikanto J, Paivansalo M, Reinikainen H, Rissanen T, Takalo R. General practitioner's
33 skills to perform limited goal-oriented abdominal US examinations after one month of intensive
34 training. *European Journal of Ultrasound*. 2002; 15(3):133-138
- 35 62 Taylor CR, Merin LM, Salunga AM, Hepworth JT, Crutcher TD, O'Day DM et al. Improving diabetic
36 retinopathy screening ratios using telemedicine-based digital retinal imaging technology: the
37 Vine Hill study. *Diabetes Care*. 2007; 30(3):574-578
- 38 63 Thomas R, Cook A, Main G, Taylor T, Galizia CE, Swingler R. Primary care access to computed
39 tomography for chronic headache. *British Journal of General Practice*. 2010; 60(575):426-430

- 1 64 Verstraete KL, Huyse WCJ. Health technology assessment of magnetic resonance imaging of the
2 spine and bone marrow. *European Journal of Radiology*. 2008; 65(2):201-210
- 3 65 Waite K, Silver F, Jaigobin C, Black S, Lee L, Murray B et al. Telestroke: a multi-site, emergency-
4 based telemedicine service in Ontario. *Journal of Telemedicine and Telecare*. 2006; 12(3):141-
5 145
- 6 66 Weiner SN. Radiology by nonradiologists: is report documentation adequate? *American Journal*
7 *of Managed Care*. 2005; 11(12):781-785
- 8 67 Whitfield MJ. The general practitioner and x-ray facilities. *Practitioner*. 1973; 210(260):780-783
- 9 68 Wilson C, Horton M, Cavallerano J, Aiello LM. Addition of primary care-based retinal imaging
10 technology to an existing eye care professional referral program increased the rate of
11 surveillance and treatment of diabetic retinopathy. *Diabetes Care*. 2005; 28(2):318-322
- 12 69 Wordsworth S, Scott A. Ultrasound scanning by general practitioners: is it worthwhile? *Journal of*
13 *Public Health Medicine*. 2002; 24(2):88-94
- 14 70 Yates J, Royse CF, Royse C, Royse AG, Canty DJ. Focused cardiac ultrasound is feasible in the
15 general practice setting and alters diagnosis and management of cardiac disease. *Echo Research*
16 *and Practice*. 2016; 3(3):63-69
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Appendices

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Appendix A: Review protocol

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Table 2: Review protocol: GP access to radiology

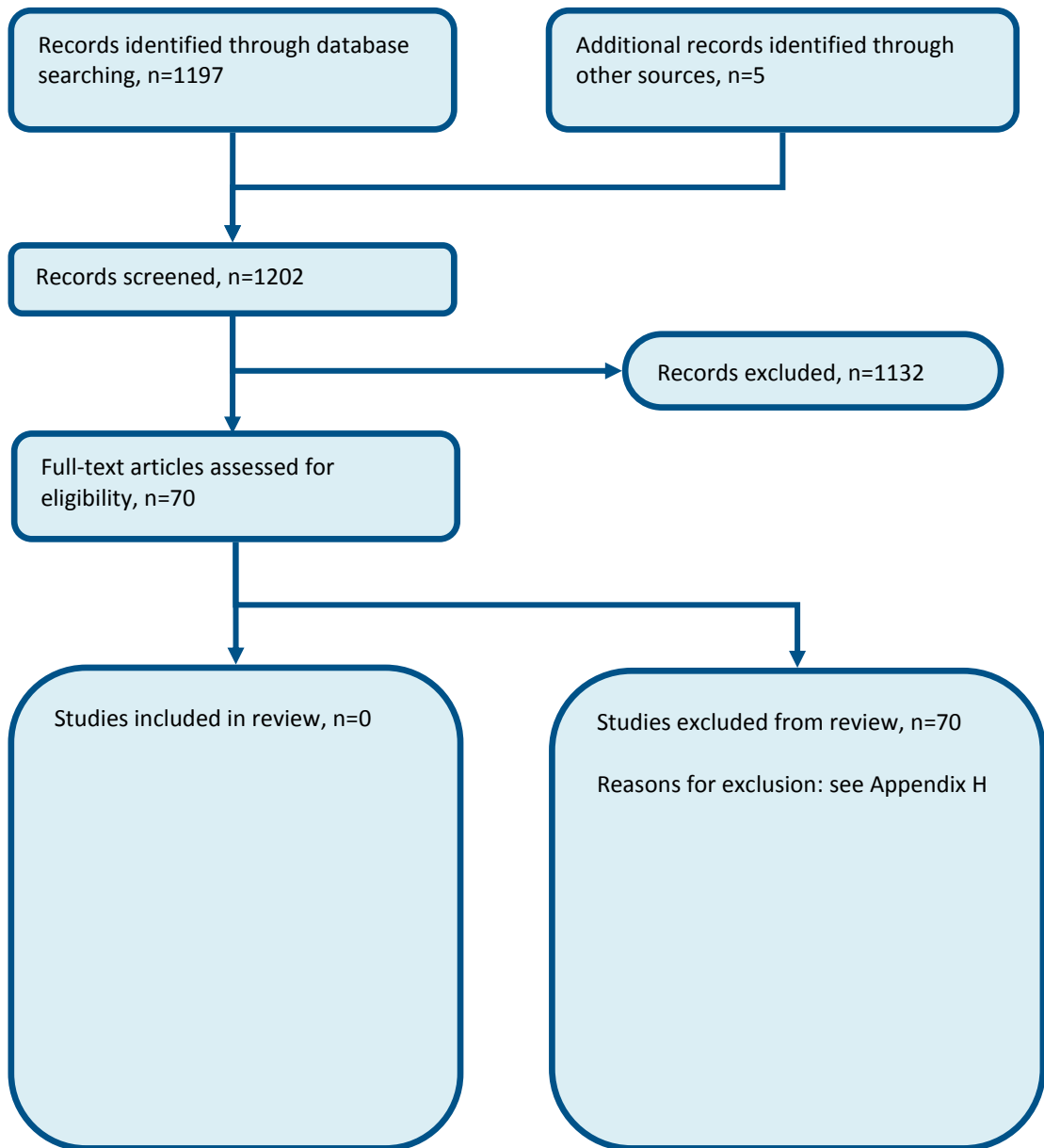
Review question	Does GP access to radiology and ultrasound with same day results improve outcomes?
Guideline condition and its definition	AME. Definition: people with suspected or confirmed acute medical emergencies.
Objectives	To determine if enhanced GP access to radiological and ultrasound investigations improves outcomes.
Review population	Adults and young people (16 years and over) presenting to a GP with a suspected or confirmed AME.
	Line of therapy not an inclusion criterion.
Interventions and comparators: generic/class; specific/drug (All interventions will be compared with each other, unless otherwise stated)	GP access to same day radiological (plain film) and ultrasound (including Doppler) investigations with same day results at weekdays (out of hours) and weekends. GP access to same day radiological (plain film) and ultrasound (including Doppler) investigations without same day results. Standard services- GP access to same day plain film radiology during working hours (weekdays) with same day results.
Outcomes	<ul style="list-style-type: none"> - Mortality during the study period (Dichotomous) CRITICAL - Avoidable adverse events (including delay in diagnosis and treatment, misdiagnosis) during the study period (Dichotomous) CRITICAL - Quality of life during the study period (Continuous) CRITICAL - ED attendance during the study period (Dichotomous) CRITICAL - Admissions during the study period (Dichotomous) CRITICAL - Patient and/or carer satisfaction during the study period (Dichotomous) CRITICAL - Laboratory or Diagnostic turn around for result to GP during the study period (Dichotomous) (IMPORTANT)
Study design	Systematic reviews (SRs) of RCTs, RCTs, observational studies only to be included if no relevant SRs or RCTs are identified.
Unit of randomisation	Patient GP surgeries/practices.
Crossover study	Not permitted.
Minimum duration of study	Not defined.
Exclusions	None
Subgroup analyses if there is heterogeneity	- Frail elderly (Frail elderly; No frail elderly); Effects may be different in this group.
Search criteria	The databases to be searched are: Medline, Embase, the Cochrane Library Date limits for search: None Language: English only.

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Appendix B: Clinical article selection

Figure 1: Flow chart of clinical article selection for the review of GP access to radiology



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Appendix C: Forest plots

No studies were included.

Appendix D: Clinical evidence tables

No studies were included.

Appendix E: Economic evidence tables

No studies were included.

Appendix F: GRADE tables

No studies were included.

1 Appendix G: Excluded clinical studies

2 **Table 3: Studies excluded from the clinical review**

Study	Exclusion reason
Apthorp 1998 ¹	Incorrect interventions. MRI not in protocol
Benamore 2005 ²	Incorrect interventions. CT not in protocol
Blois 2012 ³	Incorrect comparison (GP screening for abdominal aortic aneurysm versus ultrasound technician)
Bui 2004 ⁴	1/3 of population under 16 years old.
Bury 1987 ⁵	Narrative paper
Carey 1989 ⁶	No outcomes of interest
Castro 2007 ⁷	Incorrect interventions (retinal digital images)
Chan 1999 ⁸	Inappropriate comparison
Chaptini 2010 ⁹	Incorrect interventions (ambulatory cardiac single-photon emission computed tomography)
Collie 1999 ¹⁰	Incorrect interventions. MRI not in protocol
Detar 1960 ¹¹	Qualitative study
Duncan 2005 ¹²	Not a comparative study
Durham 1999 ¹³	Not a comparative study
Farrell 1977 ¹⁴	Not a comparative study
Fassiadis 2005 ¹⁵	Incorrect interventions (screening for abdominal aortic aneurysm)
Frohwein 2001 ¹⁶	Narrative paper
Geary 2007 ¹⁷	Not review population
Gravil 1998 ¹⁸	Incorrect comparison (treated in hospital versus treated at home)
Guldbrandt 2015 ¹⁹	Incorrect population (lung cancer patients)
Haber 1978 ²⁰	Narrative paper
Hahn 1988 ²¹	Narrative paper
Halvorsen 1989 ²²	Incorrect comparison (GP versus radiologist interpretation)
Hammond 2000 ²³	Narrative
Hawksworth 1951 ²⁴	Case series
Howard 2005 ²⁵	Incorrect interventions. Neuroimaging not in protocol
Hussain 1999 ²⁷	Incorrect comparison (comparing images sent via differing transition methods)
Hussain 2004 ²⁶	No outcomes of interest
Ingeman 2015 ²⁸	No outcomes of interest
Katerndahl 1982 ²⁹	Narrative
Kiuru 2002 ³⁰	Incorrect comparison (GP sending some x-rays to hospital for interpretation versus sending all).
Kuritzky 1987 ³¹	Incorrect interventions (interpretation of x-rays by GP versus radiologist)
Laerum 2001 ³²	Narrative
Lahde 2002 ³³	Not an intervention study
Laine 1998 ³⁴	Incorrect comparison (comparing ultrasound, clinical exam and radiography)
Laws 2006 ³⁵	Not a comparative study. No outcomes of interest.

Study	Exclusion reason
Leiro-fernandez 2014 ³⁶	Incorrect interventions (system to alert pulmonologists of lung cancer suspicion)
Li 1999 ³⁷	Incorrect interventions (screening for glaucoma)
Li 2011 ³⁸	Incorrect interventions (ocular telehealth)
Maurin 2014 ³⁹	Not review population
Mclain 1985 ⁴⁰	Inappropriate comparison (GP versus radiologist interpretation)
Merrington 1981 ⁴¹	Narrative
Miller 2006 ⁴²	Not a comparative study
Mjolstad 2012 ⁴³	Inappropriate comparison
Morioka 2007 ⁴⁴	No outcomes of interest
Olayiwola 2011 ⁴⁵	Incorrect interventions
Osmond 1977 ⁴⁶	Narrative
Oswald 1964 ⁴⁷	Narrative
Oswald 1964 ⁴⁸	Narrative
Paakkala 1988 ⁴⁹	Inappropriate comparison (GP versus radiologist interpretation)
Pavlicek 1999 ⁵⁰	No outcomes of interest
Pickhardt 2006 ⁵¹	Not a comparative study
Qureshi 2001 ⁵²	Does not match protocol (diagnostic accuracy of Doppler ultrasound)
Rawson 1965 ⁵³	Inappropriate comparison (GP versus hospital clinician)
Redmond 2013 ⁵⁴	Inappropriate comparison (GP versus radiologist interpretation)
Rogers 2010 ⁵⁵	Narrative paper
Romero-aroca 2010 ⁵⁶	Incorrect interventions (screening for retinopathy)
Smith 1993 ⁵⁷	Not a comparative study
Speets 2006 ⁵⁸	Not a comparative study
Stoddart 1989 ⁵⁹	Not a comparative study
Strasser 1987A ⁶⁰	Unclear when results were received by the GP for control group.
Suramo 2002 ⁶¹	Incorrect interventions (accuracy of ultrasound scans performed by GPs)
Taylor 2007 ⁶²	Incorrect interventions (retinopathy screening)
Thomas 2010 ⁶³	Incorrect interventions. CT not in protocol
Verstraete 2008 ⁶⁴	Incorrect interventions (MRI)
Yates 2016 ⁷⁰	Incorrect comparison (access versus no access)
Waite 2006 ⁶⁵	Incorrect interventions (CT)
Weiner 2005 ⁶⁶	Inappropriate comparison
Whitfield 1973 ⁶⁷	No outcomes of interest
Wilson 2005 ⁶⁸	Incorrect interventions (retinal imaging)
Wordsworth 2002 ⁶⁹	No outcomes of interest

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1 **Appendix H: Excluded economic studies**

2 No studies were excluded.

3