Fatima’s story with secondary mitral regurgitation

A Costed Integrated Patient Scenario

ENTER

July 2024

FOR HEALTHCARE LEADERS HSJ

Wilmington Healthcare

Executive summary

Mitral regurgitation (MR) is a serious but treatable form of heart valve disease (HVD). It is notoriously underdiagnosed and undertreated, which leads to poor outcomes for patients and avoidable strain on services.

This case study uses a fictional but realistic patient, Fatima, to compare typical care with an optimal care pathway for secondary MR. Her story illustrates how changes in the management and treatment of MR can help clinicians and commissioners improve the overall value and outcomes of the care pathway. It highlights the importance of early detection and treatment to enable patients to recover and live full and healthy lives. The longer patients wait for diagnosis and treatment, the more likely they are to deteriorate and require unplanned hospital care, diminishing the chances of successful intervention. Our financial analysis of Fatima's care also demonstrates that the suboptimal pathway is more costly overall.

The health system has a significant opportunity to improve outcomes for patients with secondary MR, particularly through better follow-up and monitoring of patients at high risk of developing the condition, who, like Fatima, have been diagnosed with heart failure (HF) or myocardial infarction (MI).

More resources are needed to commission fully integrated patient pathways that allow prompt detection, diagnosis and monitoring of MR, including increased echocardiography service capacity, so that all patients have prompt access to diagnostic services before their condition deteriorates. Once patients are diagnosed, the system needs to be prepared to offer life-saving treatment options to replace or repair valves for patients where clinically appropriate, before it's too late.

To enable this treatment to be delivered, more service capacity is needed in specialist heart centres. Current commissioning arrangements are inadequate: of the 23 centres undertaking mitral transcatheter edge-to-edge repair (M-TEER) procedures in England, only eight are formally commissioned,[1] and this commissioning covers only primary MR.[2,3] While there are commissioning policy plans to increase the number of M-TEER procedures carried out for MR patients, it is unclear how systems will cope, and what's more, the proposed increase is undoubtedly insufficient to address the scale of unmet need.

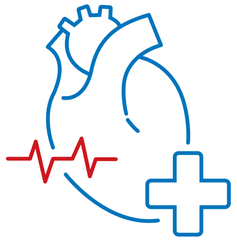
Despite the challenges, many opportunities exist to improve care and outcomes for people with secondary MR in the current NHS landscape. By comparing Fatima's pathways of care, the goal is to inspire more stakeholders to think strategically and collaboratively about engagement, education and designing optimal care pathways for people with secondary MR.

What is mitral regurgitation?

Mitral regurgitation (MR) is a form of mitral valve disease. It is one of the most common heart valve diseases (HVDs) worldwide, affecting around 2% of the population.[4]

MR occurs when the heart's mitral valve does not close properly and blood flows in the wrong direction. When MR is severe, correct blood flow through the heart and body are compromised resulting in fatigue and breathlessness, which can have serious implications on health and mortality.[5] Many people are unaware of their condition because MR can progress slowly and remain asymptomatic for many years.[4,5] In others MR develops rapidly, causing sudden signs and symptoms.[5]

Our analysis of Hospital Episode Statistics (HES) data highlights that for inpatients who received a new diagnosis of MR in hospital, the large majority, 50,580 (2023/24) presented with secondary MR. Commissioning for MR treatment provision however primarily focuses on primary MR (abnormality of the valve itself) rather than secondary MR (which develops as a result of existing abnormalities in the left side of the heart). It is very important that secondary MR is given sufficient consideration to ensure patients get the care and treatment they need.



372,050
estimated people with moderate to severe MR ≥65 years old in England (mid 2022)[11,12]

View ICB prevalence estimates

55,060
patients admitted to hospital with a new diagnosis of MR (2023/24)

9 in 10
patients presented with secondary MR

See analysis methodology

Strain of emergency care

HVD, including MR, is notoriously underdiagnosed, which leads to poor outcomes for patients and avoidable strain on services.

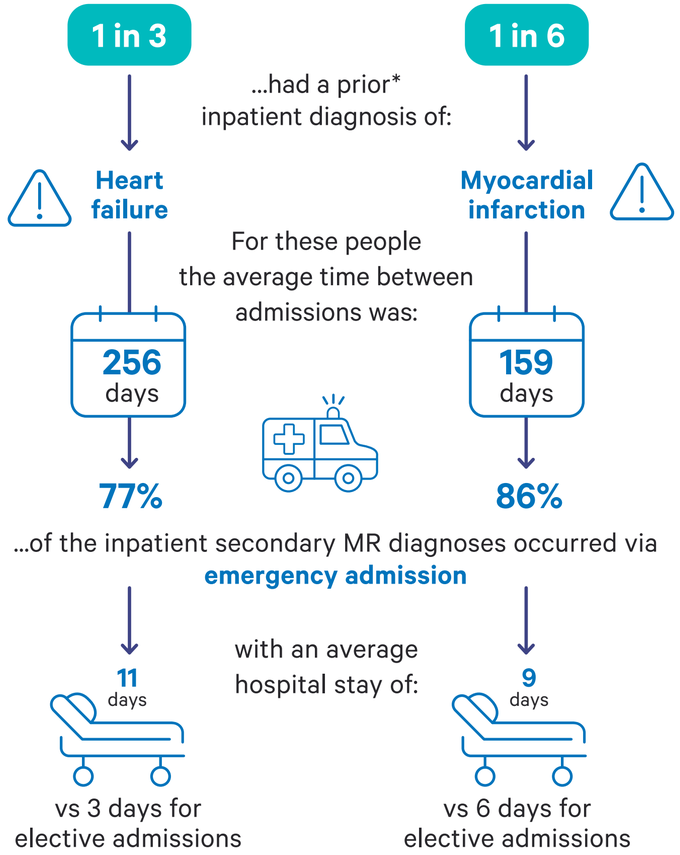
MR is poorly recognised and frequently goes unnoticed or common symptoms like breathlessness and reduced exercise tolerance are mistaken for ageing by patients and clinicians. Furthermore, General Practitioners (GPs) are seeing fewer patients face-to-face and therefore opportunities for chest auscultation to identify a heart murmur indicative of MR may be missed. For patients with a heart murmur who are referred to echocardiography for diagnosis, echocardiography service capacity is under enormous pressure and there are significant backlogs. All of these challenges contribute to the high levels of underdiagnosis for MR.

Are opportunities to diagnose MR through routine monitoring being missed?

Our HES data analysis finds that a significant proportion of the people who receive an inpatient diagnosis of secondary MR have previously been diagnosed with heart failure (HF) or myocardial infarction (MI) during a prior hospital stay. For the vast majority of these patients, the secondary MR diagnosis comes about through emergency admission.

This is a clear indicator that closer monitoring of patients who are diagnosed with HF or MI is needed. With improved monitoring of HF and MI patients, there is the potential to detect secondary MR earlier, preventing a large number of unnecessary emergency admissions.

In people with an inpatient diagnosis of **secondary MR:**



See analysis methodology

*Included in this analysis are patients who received their first diagnosis of heart failure or myocardial infarction during the same spell that they received their secondary MR diagnosis. Data is for the 2-year period 2022/2023 and 2023/2024.

Opportunities for life-saving treatment

Increased service capacity is needed in specialist heart centres to ensure treatment can be delivered to people with MR before it's too late.

Medical therapy helps with symptom management but does not slow the progression of MR,[4] whereas intervention can treat the condition effectively. This can be surgical (mitral valve repair or mitral valve replacement) or by mitral transcatheter edge-to-edge repair (M-TEER).[4] The choice between repair or replacement depends on factors such as risk of MR recurrence and postprocedural morbidity and mortality.[4,6-8]

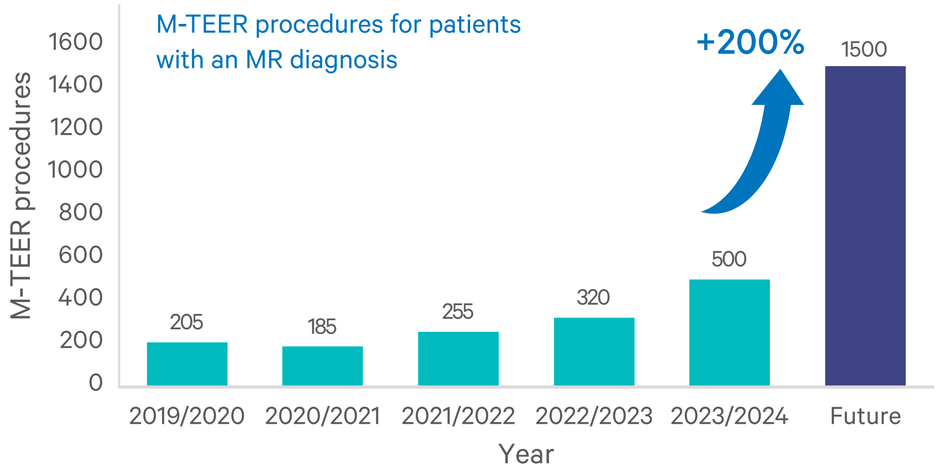
While intervention is an option for patients who get a timely diagnosis, access to this life-saving treatment is currently limited by the lack of treatment centres (only eight centres in England are formally commissioned for M-TEER),[1] and current commissioning guidance (which only supports M-TEER for primary MR).[2,3] This has led to insufficient capacity in the MR patient pathway. As you will see in Fatima's story, often by the time patients are identified to have MR, their condition has already deteriorated, leaving it too late for them to benefit from treatment. Inadequate detection, late treatment or no treatment, frequently leads to a devastating outlook for patients.

Our HES analysis shows that although the number of M-TEER procedures carried out for patients with MR has increased somewhat over the last five years (500 in 2023/24), only 1 in 3 is for patients with secondary MR. The likely reason for this is that commissioning guidance for MR treatment is focused on primary MR.

*estimated figure provided by expert group for upcoming updated commissioning guidance.

However, commissioning policy is changing in England, and new guidance may increase the number of M-TEER procedures to ~ 1,500* procedures annually (a 200% increase). While this is promising for patients, it raises two key concerns.

First, how systems will cope with developing the increased capacity to deliver such a large increase. Second, whether realistically 1,500 M-TEER procedures will be enough given the scale of MR in the population and the existing backlog. Our HES analysis shows that 2023/24 saw 55,060 inpatients receive a new diagnosis of MR. While many of these will not require and/or be eligible for M-TEER, even if just 1 in 20 for example were to undergo the procedure this totals almost 2,500 M-TEER procedures.



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Patient experiences compared

Despite the challenges, many opportunities exist to improve care and outcomes for people with MR in the current NHS landscape.

Chances to make a difference are highlighted by this case study using a fictional but realistic patient, Fatima, to compare typical care with an optimal care pathway for secondary MR.

Our Delphi-style consensus process involves experts in this specialist field to map each stage of Fatima's clinical journey, as well as looking at the personal impact on her and her family, alongside an economic analysis methodology which models the financial costs of care to the local health economy. This approach is intended to help commissioners and providers consider the implications, both in terms of quality of life and costs, of different care pathways for patients with secondary MR.

Fatima's experience sets out standard or typical practice based on the consensus of the specialists. It also highlights suboptimal pinchpoints that are found in many pathways throughout the country, as well as best practice points, which may in some cases be beyond current recommended practice but are being trialled in some areas.

By comparing pathways of care, this approach demonstrates how changes in the management and treatment of MR can help clinicians and commissioners improve the overall value and outcomes of the care pathway. The goal is to inspire more stakeholders to think strategically and collaboratively about engagement, education and designing optimal care pathways for people with secondary MR.

Go to Fatima's experience with secondary MR

Secondary mitral regurgitation
Costed integrated patient scenario

Meet Fatima
2021

Optimal pathway

- Post-MI hospital follow-up to optimise medicines – includes an echo which detects worsening MR
- Attends flexible cardiac rehab
- Frequent monitoring in heart failure clinic prompts referral for valve repair consideration
- Undergoes trans-oesophageal echo to assess suitability for M-TEER
- Expert valve MDT reviews for M-TEER and decides to go ahead
- Undergoes M-TEER valve repair intervention
- Enjoying much better health at six-week follow-up
- Keeps up with careful monitoring
- Fatima's echo shows mild/no MR
- Medication helps manage heart failure
- Happy and active

Typical pathway

- Post-MI GP follow-up to optimise medicines
- Gives up on cardiac rehabilitation
- Does not seek help despite shortness of breath
- Breathlessness worsens
- GP prescribes antibiotic at annual CHD review
- Increasingly inactive due to breathlessness
- GP requests an echo
- Echo triggers GP referral to heart failure clinic
- Clinic appointment cancelled
- Admitted to A&E gasping for breath
- Emergency admission in respiratory crisis
- Deterioration prompts urgent referral for intervention
- Death
- Fatima dies before having an opportunity to discuss intervention options

2022 | 2023 | 2024

Heart attack

- Admitted to A&E with chest pain
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£15,272

Pathway cost comparison

£20,588

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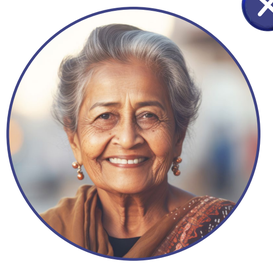

Fatima, age 75, has COPD and lives in Norwich with her husband, 80. They are both retired and Fatima helps care for him when he's feeling poorly, and he can no longer drive.

Fatima loves spending time with her three grandchildren who all live close by. She picks them up from school each afternoon and looks after them while their parents finish work.

Profile:

- South Asian
- Obesity (BMI 32)
- High blood pressure → Amlodipine 5 mg
- High cholesterol → Atorvastatin 10 mg
- History of COPD → Triple or dual therapy inhaler (1 puff OD)

Medication:

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Heart attack

Fatima has grumbling chest pain for three days. She doesn't contact her GP, but her family gets increasingly worried and phones 111 who call an ambulance. After an ECG the A&E staff diagnose her with a heart attack called STEMI (ST-elevation myocardial infarction).[a] She is given pain relief, an anti-emetic and treatment for STEMI[b] and transferred urgently by ambulance to the interventional cardiology team at Norfolk and Norwich University Hospital, who find a blockage in one of the heart arteries.[c] She undergoes a pPCI (primary percutaneous coronary intervention) to implant a stent which successfully opens the artery.

The next day she has an echocardiogram ("echo") which shows mild/moderate MR (mitral valve regurgitation) and mildly reduced LVEF (left ventricular ejection fraction).[d] Her blood results also indicate she has mild CKD (chronic kidney disease).[e] After three days she is discharged with heart medication[f] and invited to start cardiac rehabilitation. The discharge letter is sent to Fatima and her GP, enabling the practice to allocate her the CHD (coronary heart disease) code which ensures she is registered for annual review.

a. ECG showed ST elevation and pathological Q waves.
b. IV morphine and ondansetron, loading dose aspirin 300 mg and P2Y12 anti-platelet ticagrelor 180 mg. Routine blood tests: FBC, U&Es, creatinine, troponin, glucose, cholesterol.
c. Occlusion of a large circumflex coronary artery.
d. LVEF 50%.
e. CKD II.
f. Aspirin 75 mg OD lifelong, ticagrelor 90 mg BD 12 months, bisoprolol 1.25 mg OD lifelong, ramipril 1.25 mg OD lifelong and atorvastatin 80 mg OD.

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Post-MI GP follow-up to optimise medicines

In the typical pathway scenario, Fatima's discharge letter recommends a GP review six weeks after discharge to see if her medications need optimising. The GP does not adjust her medication; however, she is encouraged to keep up with her cardiac rehab.

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Gives up on cardiac rehabilitation

At home she starts going to cardiac rehab. However, the rehab is held in person 15 miles away and she finds it difficult to manage alongside caring for her husband and grandchildren and stops attending. She only attends three of the 12 sessions.

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Does not seek help despite shortness of breath

Fatima gets moving again after her heart attack but notices she's short of breath. She isn't too worried though – she puts it down to being laid up in hospital, her COPD and getting older.

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Breathlessness worsens

Fatima wants to be more active, but the breathlessness is getting worse and makes it very difficult to look after the grandchildren. She dismisses the family's concerns; after all it's probably her COPD she says. She has so many responsibilities that it's difficult to acknowledge there might be a problem.

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GP requests an echo

GP prescribes antibiotic at annual CHD review

A year after the heart attack, her GP calls her in for an annual CHD (coronary heart disease) review.[a] Fatima explains she's been increasingly breathlessness over the last nine months, with some wheeze and cough too. She is still using her inhaler for her COPD. The GP prescribes antibiotics in case of chest infection and advises losing weight.

a. BP is satisfactory/lower end normal. Ramipril not increased as BP is acceptable; concerns about worsening CKD/eGFR. Starts 10 mg dapagliflozin for CKD. Ticagrelor stopped at 12 months post-STEMI/pPCI.

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Increasingly inactive due to breathlessness

Fatima starts going for walks in an effort to get healthier. However, she finds it very difficult with the breathlessness and has to stop frequently. Feeling disappointed she's not as young as she used to be, she eventual gives up on walking altogether.

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GP requests an echo

Fatima's family worries the breathlessness can't just be down to age and nag her to see the doctor. Auscultating her heart and chest with a stethoscope, the GP detects a murmur which could explain[a] her shortness of breath. The GP requests blood tests, chest X-ray and an echo and Fatima is optimistic her problem could be treatable.

a. Blood tests: NT pro-BNP, plus U&Es, creatinine, FBC, glucose. Introduces furosemide 40 mg OD.

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Happy and active

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Echo triggers GP referral to heart failure clinic

Fatima waits three months for her echo and chest X-ray. During that time her breathlessness gets even worse. She is doing less and less now, unable to look after her grandchildren and scared to drive anywhere. When the GP gets the results 10 days later she is called in for a checkup.

It's not good news, her heart is deteriorating:[a] she has some MR, and worse LV dysfunction which remains the biggest concern, and is now at stage 3[a] (moderate) CKD. The echo results show she has heart failure so the GP adjusts her medication for this and refers her to the community heart failure clinic.[b]

a. LVEF 40%. Chest X-ray shows some mild non-specific changes, NT pro-BNP is raised.
b. GP checks U&Es and increases ramipril. Medication is now: aspirin 75 mg OD, atorvastatin 80 mg OD, bisoprolol 2.5 mg OD, ramipril 2.5 mg OD, furosemide 40 mg OD. GP also wants to introduce spironolactone, but would need to monitor U&Es following the increase in ramipril before considering this.

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After waiting two months Fatima is relieved she'll be seeing the community heart failure service later this week, but the clinic phones to cancel. Her appointment is rebooked – it will be another four week wait.

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- STEMI diagnosed
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Gives up on cardiac rehabilitati

Undergoes trans-oesophageal echo to assess suitability for

Expert valve MDT reviews for M-TEER and decides

breath

Undergoes M-TEER valve repair intervention

Enjoying much better health at six-week follow-up

annual CHD review

GP requests an echo

to heart failure clinic

Increasingly inactive due to breathlessness

Clinic appointment cancelled

Keeps up with careful

Admitted to A&E gasping for breath

Emergency admission in respiratory crisis

Deterioration prompts urgent referral for intervention

- Fatima's echo shows mild/no MR
- Medication helps manage heart failure

Happy and active

2024

Death

Fatima dies before having an opportunity to discuss intervention options

£15,272

Pathway cost comparison

£20,588

Admitted to A&E gasping for breath

Fatima is now breathless even sitting in her chair, but thinks perhaps it's the COPD playing up or a chest infection. However, when she starts gasping for breath at a family supper it sparks alarm and her son immediately calls an ambulance. In A&E an ECG indicates atrial fibrillation. She is discharged after two nights in hospital treated with medication.[a] The staff explain how important it is that she attends her next heart failure clinic appointment coming up in six weeks.

a. Heart rate >100 bpm. Digoxin is given for rate control due to concerns about her low BP (rather than increasing bisoprolol). She is given more diuretics and anticoagulant medicines. The clinician thinks she might have a chest infection and prescribes antibiotics too. Full medication: aspirin 75 mg OD, rivaroxaban 15 mg OD, bisoprolol 2.5 mg OD, digoxin 125 mcg OD, furosemide 40 mg AM, ramipril 2.5 mg OD, lansoprazole 30 mg OD.

Secondary mitral regurgitation
Costed integrated patient scenario

Undergoes M-TEER valve repair intervention

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Happy and active

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Attends flexible cardiac rehab

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Optimal pathway

Typical pathway

£15,272

Pathway cost comparison

£20,588

2024

Meet Fatima 2021

Heart attack

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Emergency admission in respiratory crisis

Death

Fatima dies before having an opportunity to discuss intervention options

Increasingly inactive due to breathlessness

Clinic appointment cancelled

Deterioration prompts urgent referral for intervention

Emergency admission in respiratory crisis

Not long after, however, she wakes up one night feeling unable to breathe, as though she is drowning. She calls an ambulance and spends seven days in the coronary care unit with overt pulmonary oedema, severe LV impairment and severe secondary MR, moderate TR.[a]

When she gets home she really struggles to manage. Although she can still do some cooking, she's unable to care for her husband or do any cleaning or shopping. After a needs assessment a carer starts coming in for two hours a week.

a. Chest X-ray shows upper lobe diversion, pulmonary congestion bilateral lung fields. Echo shows severe LV impairment (LVEF 40%) and severe secondary MR, moderate TR, and estimated pulmonary pressures 40 mmHg. Medication: switched from tablet to IV furosemide 80 mg BD in hospital, discharged on oral furosemide 40 mg AM and 20 mg PM.

Meet Fatima
2021

Optimal pathway

Typical pathway

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Emergency admission in respiratory crisis

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GP referral to heart failure clinic

GP requests an echo

antibiotic at annual CHD review

shortness of breath

Increasingly inactive due to breathlessness

Clinic appointment cancelled

Deterioration prompts urgent referral for intervention

Deterioration prompts urgent referral for intervention

The heart failure team sees Fatima every two weeks. They continue trying to optimise her medications[a] but she isn't improving so they arrange an urgent echo. Over the next six appointments she continues to deteriorate[b] and they make an urgent referral to the tertiary centre expert valve team at Papworth to discuss transcatheter heart valve intervention.

a. Breathlessness NYHA class III symptoms. Not overtly decompensated. Medication optimisation: spironolactone 12.5 mg OD introduced. U&Es checked after two weeks and BP checked: eGFR now 35, BP around 100 mmHg. Ramipril increased to 3.75 mg OD. Seen after two weeks: eGFR 35, BP 100 mmHg. Spironolactone increased to 25 mg OD. Seen again after two weeks, eGFR 30.

b. Echo results show LVEF 30%, severe functional MR, moderate TR, pulmonary artery BP 55 mmHg.

Undergoes M-TEER valve repair intervention

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Admitted to A&E gasping for breath

Emergency admission in respiratory crisis

Death

Fatima dies before having an opportunity to discuss intervention options

Increasingly inactive due to breathlessness

Clinic appointment cancelled

Deterioration prompts urgent referral for intervention

Fatima dies before having an opportunity to discuss intervention options

While waiting for an appointment to discuss intervention options, Fatima is once again rushed into hospital in the middle of the night. She is admitted to cardiac high care in a very bad way, with severe pulmonary oedema and kidney failure.[a] Ventilation, intensive care and even referral to the tertiary centre are options, but the outlook is so poor that the team, together her family, decide on supportive care. After 10 days in hospital – and three years on from her first heart attack – Fatima dies with multi-organ failure.

a. Medication: oxygen, IV diuretics, 2.5 mg dopamine infusion and some dobutamine. The cardiology team are directly involved. They stop her bisoprolol and start some digoxin.

Secondary mitral regurgitation
Costed integrated patient scenario

Meet Fatima
2021

Optimal pathway

Typical pathway

Heart attack
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- pPCI stent implant
- MR and CKD identified
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an echo

clinic

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Death

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2024

Pathway cost comparison

£15,272

£20,588

- Fatima's echo shows mild/no MR
- Medication helps manage heart failure

Happy and active

Post-MI hospital follow-up to optimise medicines– includes an echo which detects worsening MR

In the optimal pathway scenario, Fatima's discharge letter says the hospital cardiology team has arranged a six-week routine post-MI follow-up appointment led by the specialist nurse. They have also booked a follow-up echo for eight weeks post-discharge.

Comparing this follow-up echo against the echo report from her admission, the echocardiographer finds features suggesting things have got worse: moderate MR and LVEF 50%. The echocardiographer speaks to the cardiologist who advises adjusting her medication, referral to community heart failure service and a repeat echo in six to eight weeks. She is encouraged to continue with her cardiac rehab appointments and her medication is optimised.[a]

a. Bringing her ramipril to 2.5 mg, therefore her full medication is now: aspirin 75 mg OD lifelong, ticagrelor 90 mg BD, bisoprolol 2.5 mg OD, ramipril 2.5 mg OD, and atorvastatin 80 mg OD.

Secondary mitral regurgitation
Costed integrated patient scenario

Meet Fatima
2021

Optimal pathway

Typical pathway

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Death

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Post-MI GP follow-up to optimise medicines

Gives up on cardiac rehabilitation

Does not seek help despite shortness of breath

Breathlessness worsens

GP prescribes antibiotic at annual CHD review

GP requests an echo

Echo triggers GP referral to heart failure clinic

Admitted to A&E gasping for breath

Emergency admission in respiratory crisis

Increasingly inactive due to breathlessness

Clinic appointment cancelled

Deterioration prompts urgent referral for intervention

£15,272

Pathway cost comparison

£20,588

Attends flexible cardiac rehab

Fatima has been offered flexible cardiac rehab with a combination of virtual and in-person appointments near her home. She feels supported and manages to attend six of the 12 sessions.

Meet Fatima
2021

Optimal pathway

Typical pathway

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Undergoes trans-oesophageal

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£15,272

Pathway cost comparison

£20,588

- Fatima's echo shows mild/no MR
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Happy and active

Frequent monitoring in heart failure clinic prompts referral for valve repair consideration

The next echo flags concerns about Fatima's MR and the heart failure clinic decides she should be discussed by a valve specialist.[a] The valve specialist adjusts her medication,[b] refers her to the expert valve MDT at Papworth, and books a trans-oesophageal echo in two months' time so the MDT can consider her for M-TEER (mitral transcatheter edge-to-edge repair). This is a minimally invasive procedure for moderately severe or severe secondary MR due to LV dysfunction.

Despite her worries about the breathlessness she's been experiencing, she is reassured to be monitored every two weeks by the heart failure team who adjust her medication.[c] The upcoming trans-oesophageal echo will help clarify matters for the valve MDT at Papworth.

a. The valve specialist reviews the results and recognises that the fall in LVEF despite optimal GDMT coinciding with worsening MR suggests significant worsening of LV function. They take particular notice of the worsening MR.
b. Ramipril 2.5 mg OD and spironolactone 12.5 mg OD introduced. SBP 110 mmHg.
c. U&Es checked. Ramipril increased to 3.75 mg OD. Following two weeks, spironolactone increased to 25mg OD.

Secondary mitral regurgitation
Costed integrated patient scenario

Meet Fatima
2021

Optimal pathway

Typical pathway

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GP requests an echo

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Happy and active

2024

Death

Fatima dies before having an opportunity to discuss intervention options

£15,272

Pathway cost comparison

£20,588

Undergoes trans-oesophageal echo to assess suitability for M-TEER

The trans-oesophageal echo is performed by a valve echo specialist. Fatima continues with her regular appointments at the heart failure clinic to monitor her condition and adjust her medication[a] and she has a CT scan at the district general hospital. The breathlessness now makes it difficult to take the grandchildren out to parks and play dates. She wants to be more active and feels down about getting older.

a. Ramipril increased to 5 mg OD with U&Es and BP monitoring. SGLTi added to therapeutic regimen. This is optimal tolerated. She has an ECG which shows normal QRS duration so there is no indication for CRT.

Secondary mitral regurgitation
Costed integrated patient scenario

Meet Fatima
2021

Optimal pathway

Typical pathway

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GP referral to heart failure clinic

antibiotic at annual CHD review

shortness of breath

Expert valve MDT reviews for M-TEER and decides to go ahead

The mitral and tricuspid valve MDT at Papworth reviews Fatima's investigations and comorbidities. The trans-oesophageal echo suggests she would be a suitable candidate for M-TEER to repair her mitral valve. Heart surgery however is not indicated.[a] At the valve clinic an interventional cardiologist explains to Fatima that M-TEER treatment is an option which could help her to feel a lot better. With her agreement and after a full assessment[b] the valve MDT decide to go ahead with treatment.

a. Fatima has secondary (ventricular) MR and no requirement for cardiac surgery for revascularisation. Isolated mitral valve surgery in secondary MR has limited evidence.
b. Frailty and functional assessment, repeat NT pro-BNP tests.

Secondary mitral regurgitation
Costed integrated patient scenario

Meet Fatima
2021

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Typical pathway

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Breathlessness worsens

Undergoes M-TEER valve repair intervention

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2024

Death

Fatima dies before having an opportunity to discuss intervention options

- Fatima's echo shows mild/no MR
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Happy and active

£15,272

Pathway cost comparison

£20,588

Undergoes M-TEER valve repair intervention

Six weeks later Fatima has routine tests[a] and is admitted for M-TEER. She is discharged 24 hours after this uncomplicated procedure. A pre-discharge echo shows no change in LVEF but a significant improvement in MR.

a. FBC, U&Es, group and save, CRP, INR completed the night before the procedure.

Secondary mitral regurgitation
Costed integrated patient scenario

Meet Fatima
2021

Optimal pathway

Typical pathway

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Fatima dies before having an opportunity to discuss intervention options

2024

£15,272

Pathway cost comparison

£20,588

- Fatima's echo shows mild/no MR
- Medication helps manage heart failure

Happy and active

Enjoying much better health at six-week follow-up

Fatima feels much better after the M-TEER procedure: she can take her grandchildren to the park again and starts losing weight. At her follow-up appointment six weeks later her echo shows only trivial MR. Her heart failure medicines are adjusted.[a]

a. Ramipril increased to 7.5 mg OD.

Meet Fatima
2021

Optimal pathway

Typical pathway

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Happy and active

2024

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Fatima dies before having an opportunity to discuss intervention options

£15,272

Pathway cost comparison

£20,588

Keeps up with careful monitoring

Fatima and her husband are careful to keep up with her appointments. They are delighted that she continues to feel better and it is reassuring to have her condition and medications monitored closely.[a] She continues with her mix of virtual and in-person cardiac rehabilitation sessions and regular appointments at the community heart failure clinic and with her GP. Each year she is reviewed at the regional valve clinic for HVD surveillance which includes an echo.

a. 12 months post-M-TEER: mild or no MR, LVEF 45% (as a result of optimal medical therapy). Maximum tolerated medications: aspirin 75 mg OD, atorvastatin 80 mg OD, bisoprolol increased to 5 mg OD, ramipril 7.5 mg OD, spironolactone 25 mg OD, dapagliflozin 10 mg OD.

Meet Fatima
2021

Optimal pathway

Typical pathway

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Fatima dies before having an opportunity to discuss intervention options

2024

£15,272

Pathway cost comparison

£20,588

Happy and active

- Fatima's echo shows mild/no MR
- Medication helps manage heart failure

Happy and active: Fatima's echo shows mild/no MR and medication helps manage heart failure

Three years after her heart attack, Fatima is doing well. The echo at her annual valve clinic review shows she has mild or no MR and her LVEF is 45–50% (as a result of medical therapy).

She can walk at her own pace on level ground and has no breathlessness at rest, although she gets a little breathless on inclines. It's a relief because it means she can get on with the things she used to do, including the housework and caring for her husband and grandchildren, albeit at a slower pace. She gets tired easily and has to take a rest in the afternoons.

She is slower than some of her friends but any worsening of her symptoms is slow and she hasn't needed any hospital stays. The heart attack has left her with heart failure, which is helped by medication for now but she knows it's expected to get worse over time. However, she appreciates any extra time she has with her family and tries her best to stay healthy.

Cost comparison

At each stage of Fatima's journey we have modelled the costs of care to help commissioners and providers understand the financial implications of different care pathways for patients with MR.

Fatima's optimal care pathway is less costly, totalling £15,272 – a saving of £5,316 against the typical pathway which costs £20,588. Moreover, at the end of the optimal scenario Fatima is living a full and active life as a result of her early diagnosis and treatment. In the scenario of typical care, Fatima waits longer for diagnosis which sees her condition deteriorate and leads to multiple unplanned admissions and ultimately to her premature death.

For more information and a breakdown of the costs, see the detailed cost comparison.

Note, financial costs are indicative and calculated on a cost-per-patient basis. Local decisions to transform care pathways would need to take a population view of costs and improvement.

Cost summary for Fatima's care[8,9,10]

Healthcare activity	Typical pathway	Optimal pathway
Community care	£2,473	£200
Primary care	£3,003	£1,922
Secondary care	£13,624	£12,396
Emergency/urgent care	£1,489	£755
Total	**£20,588**	**£15,272**

Detailed cost comparison[8,9,10]

Average pathway		Optimal pathway	
Community care	£2,473	Community care	£200
Home care	£2,473	Heart failure clinic	£200
Primary care	£3,003	Primary care	£1,922
GP appointment	£164	GP appointment	£41
Routine blood tests	£10	Aspirin	£59
Digoxin	£62	Ticagrelor	£362
Aspirin	£59	Atorvastatin	£238
Ticagrelor	£724	Bisoprolol (1.25, 2.5 mg)	£25
Atorvastatin	£238	Dapagliflozin	£962
Rivaroxaban	£384	Ramipril (1.25, 2.5, 3.75 mg)	£12
Lansoprazole	£56	Spironolactone (12.5, 25 mg)	£109
Bisoprolol (1.25, 2.5 mg)	£76	Bisoprolol (5 mg)	£51
Dapagliflozin	£962	Ramipril (5, 7.5 mg)	£62
Furosemide (40, 60 mg)	£27		
Furosemide IV (80 mg)	£25		
Ramipril (1.25, 2.5, 3.75 mg)	£74		
Spironolactone (12.5, 25, 50 mg)	£13		
Dopamine	£19		
Dobutamine (2.5, 5 mcg)	£109		
Secondary care	£13,624	Secondary care	£12,396
Chest X-ray	£28	Cardiology follow-up MDT	£154
Cardiac rehabilitation	£309	Cardiac rehabilitation	£1,545
A&E department	£944	Cardiac surgery follow-up	£524
Cardiac admission 1	£3,023	Echocardiogram	£174
Echocardiogram	£174	Heart failure clinic	£100
Heart failure clinic	£700	Cardiac admission 1	£3,023
Cardiac admission 2	£2,060	Transoesophageal echocardiogram	£533
Cardiac admission 3	£2,878	Heart failure clinic MDT	£154
Cardiac admission 4	£3,508	CT scan	£336
		Heart valve surgical clinic	£346
		Cardiac admission 2	£4,697
		HVD surveillance	£270
		Echocardiogram	£540
Emergency/urgent care	£1,489	Emergency/urgent care	£755
111 call	£21	111 call	£21
Ambulance	1,468	Ambulance	£734
Total	**£20,588**	**Total**	**£15,272**

Notes

- This is an economic analysis of health and social care; however, in an integrated service with integrated budgets it is important to understand the wider social and economic cost impact of the total patient journey, including the longer term costs to the patient and their family (e.g. social, emotional, financial).
- This financial calculation represents an indicative level of efficiency potential of this example case study only. However, pathways for other patients may increase or reduce the potential benefit. The potential to release resource by implementing the optimal pathway across a larger cohort of patients will also depend on the over-arching contractual arrangements between providers and commissioners, which may vary. For example, some of the financial benefits identified here may not be fully realisable where elements of the pathway are subject to block contracts or risk/gain shares in place between contracting parties. Equally, the release of resource may only be realised should there be a critical mass from within the targeted patient population.
- It should also be noted that the financial calculation is considered from a commissioner perspective. The impact on income and costs (including capacity management) for provider organisations will require consideration in the implementation of the optimal pathway.
- Each healthcare organisation and system will need to assess the potential for realising the financial benefits identified in the case.

Recommendations

Moderate to severe secondary MR is a serious but treatable disease. As demonstrated by Fatima's story, early detection and timely treatment of secondary MR can enable patients to recover and live full and healthy lives. The longer patients wait for diagnosis and treatment, the more likely they are to deteriorate and require unplanned hospital care, diminishing the chances of successful intervention. Suboptimal healthcare for MR is costly and carries with it a wider burden to society and the economy.

Commissioners have a significant opportunity to improve outcomes by enhancing the follow-up and monitoring of patients like Fatima who are at higher risk of developing secondary MR. Pathways that embed appropriate monitoring and have adequate echocardiography service and MR treatment capacity can ensure that the right patients are identified in time and have access to life-saving treatment.

- **Clinicians**
- **Commissioners and Cardiac Clinical Networks**
- **Patients**

Clinicians

Diagnosis

Low levels of awareness of HVD among community clinicians may lead to incorrect or delayed diagnoses and referral for diagnostic testing.

- It is important to perform chest auscultation on patients with any symptoms that may indicate HVD,[9,10] such as breathlessness, chest pain, presyncope or syncope, and to refer for echocardiography promptly if a murmur is detected.[9]
- Clear community detection pathways for MR that include diagnosis and referral into specialised services are needed in every ICS, with clinical leadership from the Cardiac Clinical Networks, to enable patients to be considered for valve repair.
- Primary care could proactively screen for symptoms of HVD during routine long-term condition annual reviews and NHS health checks.[9,10] Accurate coding of patient records is essential to this.
- Digital stethoscope technology with murmur detection AI software may be a valuable tool in identifying patients needing investigation while also reducing unnecessary echocardiography thereby relieving unwarranted pressure on the service.

Monitoring

Patients like Fatima who have been diagnosed with MI or HF are at higher risk of developing secondary MR:

- Following discharge patients must receive rapid routine follow-up by cardiology including echocardiography, medicines optimisation and frequent monitoring for signs of heart murmur or deterioration.
- Hospital discharge letters to GPs should communicate the patient's risk of HVD and the need for regular ongoing monitoring in primary care (this could be provided as a factsheet).
- GPs need a systematic method for recalling patients for regular review, including those with mild MR which can deteriorate to moderate/severe disease.

Echocardiography

- Echocardiography reporting needs to provide clear advice on the next steps for patient care. Complicated echocardiography and imaging reports may be difficult to interpret and can lead to incorrect referrals or referral delays.

Commissioners and Cardiac Clinical Networks

Integrated care pathways for MR

- Cardiac Clinical Networks should actively provide clinical leadership to the ICSs that they cover to support them with commissioning fully integrated patient pathways that allow prompt detection, diagnosis, monitoring and treatment of HVD.
- Care pathways must include rapid routine follow-up by cardiology including echocardiography and frequent monitoring for patients like Fatima who have been diagnosed with MI or HF and are therefore at higher risk of developing secondary MR.
- Ensure cardiac rehabilitation is flexible and accessible to maximise patient adherence.

Service capacity and workforce

ICB commissioners need to provide adequate service capacity in the following key areas to meet the demand for MR patients (including the patient backlog), so that all patients have prompt access to services and, if clinically appropriate, to best practice treatment options:

- Echocardiography
  Echocardiography capacity must increase to meet the demands for diagnosis and monitoring across a range of cardiac conditions, including MR. Currently access to echocardiography in the community is limited due to a lack of resource and workforce, which can exacerbate MR diagnosis and treatment days. These services could be provided in a community diagnostic hub.
- Specialist heart centres
  More service capacity is needed in specialist heart centres and commissioners must understand who can set up these specialist services. Currently M-TEER is only offered in certain areas as very few heart centres undertake the procedures (23 of 32). Furthermore, the commissioning arrangements are inadequate: only eight are formally commissioned,[1] and even so, the commissioning is focused on primary MR.[2,3] Commissioners should consider collaborating across ICBs to develop a service provision group within Cardiac Clinical Networks.
- Catheterisation labs
  Commissioners must address capacity issues in cath labs, where patients undergo pPCI (primary percutaneous coronary intervention) stent implantation (as Fatima did following her heart attack) as well as transcatheter procedures for valve replacement. It may be worth considering shifting pPCI from specialist hospitals to general hospitals to increase cath lab capacity for other procedures.

Recommendations

Moderate to severe secondary MR is a serious but treatable disease. As demonstrated by Fatima's story, early detection and timely treatment of secondary MR can enable patients to recover and live full and healthy lives. The longer patients wait for diagnosis and treatment, the more likely they are to deteriorate and require unplanned hospital care, diminishing the chances of successful intervention. Suboptimal healthcare for MR is costly and carries with it a wider burden to society and the economy.

Commissioners have a significant opportunity to improve outcomes by enhancing the follow-up and monitoring of patients like Fatima who are at higher risk of developing secondary MR. Pathways that embed appropriate monitoring and have adequate echocardiography service and MR treatment capacity can ensure that the right patients are identified in time and have access to life-saving treatment.

Patients

- The public need better awareness about the seriousness and treatability of MR and other forms of HVD, to encourage people with symptoms to come forward.
- Health literacy and patient activation impact the speed a patient may be diagnosed; patients need more education about breathlessness and how to manage MR.
- Setting treatment goals is key – patients should discuss with healthcare professionals what they would like to be able to do and achieve.

Resources

Abbreviations

A&E	Accident and emergency
BD	Twice a day
BMI	Body mass index
BP	Blood pressure
CHD	Coronary heart disease
CKD	Chronic kidney disease
COPD	Chronic obstructive pulmonary disease
CRP	C-reactive protein
CRT	Cardiac resynchronisation therapy
CT	Computed tomography
ECG	Electrocardiogram
Echo	Echocardiogram
eGFR	Estimated glomerular filtration rate
FBC	Full blood count
GDMT	Guideline-directed medical therapy
GP	General practitioner
HES	Hospital Episode Statistics
HF	Heart failure
HVD	Heart valve disease
ICB	Integrated Care Board
ICS	Integrated care system
INR	International normalised ratio
IV	Intravenous
LVEF	Left ventricular ejection fraction
MDT	Multidisplinary team
MI	Myocardial infarction
MR	Mitral regurgitation
M-TEER	Mitral transcatheter edge-to-edge repair
NT pro-BNP	N-terminal pro b-type natriuretic peptide
NYHA	New York Heart Association Functional Classification
OD	Once a day
pPCI	Primary percutaneous coronary intervention
QRS	The QRS series of deflections in an ECG represent electrical activity generated in the heart prior to contraction of the ventricles.
SGLTi	Sodium-glucose cotransporter inhibitor
STEMI	ST-elevation myocardial infarction
TR	Tricuspid regurgitation
U&E	Urea and electrolytes

Resources

Acknowledgements

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- Stephen Thomas, Senior Data Analyst, Wilmington Healthcare
- Wil Woan, Heart Valve Voice

Resources

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Resources

Analysis methods (1/8)

Sources:

Hospital Episode Statistics (HES)

ONS Mid-year Population Estimates for Clinical Commissioning Groups (CCGs) in England by Single Year of Age and Sex[11]

Cahill TJ, Prothero A, Wilson J, et al (2021), "Community prevalence, mechanisms and outcome of mitral or tricuspid regurgitation", Heart[12]

Study period:

1st April 2019 to 31st March 2024 - for HES analysis

Mid-2018 to Mid-2022 - for incidence analysis

Continue

Resources

Analysis methods (2/8)

Mitral Regurgitation (MR) - Parameters
This section defines the parameters used to identify the patient cohort who have been diagnosed with MR.

Criteria	Description
MR diagnosis	The patient has to have been admitted to hospital with a diagnosis of MR (ICD-10 codes I340 or I341) in any diagnosis position (either primary or secondary) over the study period, 1st April 2019 to 31st March 2024.
Age	The patient has to be 18 years of age or over.
Patient exclusions -based on diagnosis codes	Any patient who has been diagnosed with congenital diseases, infective endocarditis, rheumatic mitral valve disease or pulmonary valve diseases during an inpatient spell at any time over the study period has been excluded from the MR patient cohort. Please refer to the table named "MR Patient Exclusions - Based on Diagnosis Codes" on the "Codes" tab for the full list of ICD-10 codes used.
Patient exclusions - based on operation codes	Any patient who has undergone pulmonary valve surgery, mitral commissurotomy or interatrial septal closure procedures prior to their initial diagnosis of MR (but within the study period) has been excluded from the MR patient cohort. Please refer to the two tables named "MR Patient Exclusions - Based on Operation Codes" for the full list of OPCS codes used.

Secondary Mitral Regurgitation (SMR) Patient Cohort - Parameters
This section defines the additional parameters used to identify the patient cohort who have been diagnosed with SMR. These have been applied in addition to the parameters used to define the cohort with MR.

Criteria	Description
Part of MR patient cohort	The patient must already be part of the MR patient cohort (see above).
No diagnosis of mitral prolapse	Any patient that has had a diagnosis of mitral prolapse (ICD-10 code I341) as part of an inpatient spell at any time over the study period has been excluded from the SMR patient cohort.
No previous mitral surgery	Any patient who has undergone mitral surgery prior to their initial diagnosis of SMR (but within the study period) has been excluded from the MR patient cohort. Please refer to the table named "Mitral Surgery - Operation Codes" for a full list of OPCS codes used.

Continue

Resources

Analysis methods (3/8)

Data Indicators

Data Type	Description
MR and SMR	A count of patients newly diagnosed with MR or SMR at national level, based on the first inpatient spell in which the diagnosis appears within the study period, 1st April 2019 to 31st March 2024. Data is split by fiscal year.
Heart failure and myocardial infarction	Patients diagnosed with heart failure or myocardial infarction who have a subsequent diagnosis of SMR in an inpatient spell over a 2 year period (2022/2023 and 2023/2024), split by admission method of the SMR spell. Data is presented at national level. Please note that patients whose initial diagnoses of heart failure or myocardial infarction and SMR are within the same spell are included in this analysis. Patient counts, mean length of stay of SMR spell and average days and between initial diagnosis of heart failure or myocardial infarction and SMR are shown. Data relates to the subsequent SMR inpatient spell.
M-TEER procedures	A count of hospital inpatient spells where a Mitral Transcatheter Mitral Valve Edge-to-Edge Repair (TEER)) has been performed for patients diagnosed with MR. Data is split by fiscal year.
MR Prevalence (ENG & ICB)	The population with MR has been estimated by applying the adjusted prevalence benchmark from the Heart article by Cahill TJ, Prothero A, Wilson J, et al (2021) "Community prevalence, mechanisms and outcome of mitral or tricuspid regurgitation" to ONS Mid-year Population Estimates for Clinical Commissioning Groups (CCGs) in England by Single Year of Age and Sex. In this article, the estimated community prevalence of moderate or greater MR within adults aged 65+ is 3.5%.

Continue

Resources

Analysis methods (4/8)

Suppression and Rounding

Suppression	Patient counts and inpatient spell counts between 1 and 7 (inclusive) have been suppressed and are represented by *. Days from initial diagnosis of MR and mean length of stay are suppressed wherever patients are suppressed.
Rounding	Patient counts and inpatient spell counts above 7 have been rounded to the nearest 5. Days from initial diagnosis of MR is rounded to the nearest integer. Mean length of stay is rounded to one decimal place.

Continue

Resources

Analysis methods (5/8)

Codes

Mitral Regurgitation - Diagnosis Codes		
Diagnosis Type	**ICD-10 Code**	**Diagnosis Description**
Mitral regurgitation	I340	Mitral (valve) insufficiency
	I341	Mitral (valve) prolapse

Transcatheter Mitral Valve Edge-to-Edge Repair (TEER) - Operation Codes		
Procedure Type	**OPCS Code**	**Operation Description**
TEER approach code	Y534	Approach To Organ Under Fluoroscopic Control
	Y768	Minimal Access To Other Body Cavity, Other Specified
TEER procedure code	K255	Mitral Valve Repair Nec

Mitral Valve Repair/Replacement - Operation Codes		
Procedure Type	**OPCS Code**	**Operation Description**
Mitral valve replacement	K251	Allograft Replacement of Mitral Valve
	K252	Xenograft Replacement of Mitral Valve
	K253	Prosthetic Replacement of Mitral Valve
	K254	Replacement of Mitral Valve Nec
Mitral valve repair	K255	Mitral Valve Repair Nec
	K258	Plastic Repair of Mitral Valve, Other Specified
	K259	Plastic Repair of Mitral Valve, Unspecified

Heart Failure - Diagnosis Codes		
Diagnosis Type	**ICD-10 Code**	**Diagnosis Description**
Heart failure	I110	Hypertensive heart disease with (congestive) heart failure
	I130	Hypertensive heart and renal disease with (congestive) heart failure
	I132	Hypertensive heart and renal disease with both (congestive) heart failure and renal failure
	I501	Left ventricular failure
	I509	Heart failure, unspecified

Continue

Resources

Analysis methods (6/8)

Codes

Myocardial Infarction - Diagnosis Codes		
Diagnosis Type	**ICD-10 Code**	**Diagnosis Description**
Myocardial Infarction	I210	Acute transmural myocardial infarction of anterior wall
	I211	Acute transmural myocardial infarction of inferior wall
	I212	Acute transmural myocardial infarction of other sites
	I213	Acute transmural myocardial infarction of unspecified site
	I214	Acute subendocardial myocardial infarction
	I219	Acute myocardial infarction, unspecified
	I220	Subsequent myocardial infarction of anterior wall
	I221	Subsequent myocardial infarction of inferior wall
	I228	Subsequent myocardial infarction of other sites
	I229	Subsequent myocardial infarction of unspecified site

Mitral Surgery - Operation Codes		
Procedure Type	**OPCS Code**	**Operation Description**
Mitral valve surgery	K251	Allograft Replacement of Mitral Valve
	K252	Xenograft Replacement of Mitral Valve
	K253	Prosthetic Replacement of Mitral Valve
	K254	Replacement of Mitral Valve Nec
	K255	Mitral Valve Repair Nec
	K258	Plastic Repair of Mitral Valve, Other Specified
	K259	Mitral Valve Repair Nec
	K301	Revision of Plastic Repair of Mitral Valve
	K311	Open Mitral Valvotomy
	K321	Closed Mitral Valvotomy
	K341	Annuloplasty of Mitral Valve
	K351	Percutaneous Transluminal Mitral Valvotomy

Continue

Resources

Analysis methods (7/8)

Codes

MR Patient Exclusions - Based on Diagnosis Codes		
Diagnosis Type	**ICD-10 Code**	**Diagnosis Description**
Congenital diseases	Q230	Congenital stenosis of aortic valve
	Q231	Congenital insufficiency of aortic valve
	Q232	Congenital mitral stenosis
	Q233	Congenital mitral insufficiency
	Q234	Hypoplastic left heart syndrome
	Q238	Other congenital malformations of aortic and mitral valves
	Q239	Congenital malformation of aortic and mitral valves, unspecified
Infective endocarditis	I330	Acute and subacute infective endocarditis
Rheumatic mitral valve disease	I050	Mitral stenosis
	I051	Rheumatic mitral insufficiency
	I052	Mitral stenosis with insufficiency
	I058	Other mitral valve diseases
	I059	Mitral valve disease, unspecified

MR Patient Exclusions - Based on Diagnosis Codes		
Diagnosis Type	**ICD-10 Code**	**Diagnosis Description**
Pulmonary valve diseases	I370	Pulmonary valve stenosis
	I371	Pulmonary valve insufficiency
	I372	Pulmonary valve stenosis with insufficiency
	I378	Other pulmonary valve disorders
	I379	Pulmonary valve disorder, unspecified
	Q220	Pulmonary valve atresia
	Q221	Congenital pulmonary valve stenosis
	Q222	Congenital pulmonary valve insufficiency
	Q223	Other congenital malformations of pulmonary valve
	Q224	Congenital tricuspid stenosis
	Q225	Ebstein anomaly
	Q226	Hypoplastic right heart syndrome
	Q228	Other congenital malformations of tricuspid valve
	Q229	Congenital malformation of tricuspid valve, unspecified

Continue

Resources

Analysis methods (8/8)

Codes

MR Patient Exclusions - Based on Operation Codes		
Procedure Type	**OPCS Code**	**Operation Description**
By OPCS code at 4 character level		
Pulmonary valve surgery	K045	Repair of Tetralogy of Fallot With Absent Pulmonary Valve
	K281	Allograft Replacement of Pulmonary Valve
	K282	Xenograft Replacement of Pulmonary Valve
	K283	Prosthetic Replacement of Pulmonary Valve
	K284	Replacement of Pulmonary Valve Nec
	K285	Pulmonary Valve Repair Nec
	K288	Plastic Repair of Pulmonary Valve, Other Specified
	K289	Plastic Repair of Pulmonary Valve, Unspecified
	K304	Revision of Plastic Repair of Pulmonary Valve
	K314	Open Pulmonary Valvotomy
	K324	Closed Pulmonary Valvotomy
	K331	Aortic Root Replacement Using Pulmonary Valve Autograft With
	K332	Aortic Root Replace Pulmonary Valve Autograft Rt Ventricle
	K336	Aortoventriculoplasty With Pulmonary Valve Autograft
	K346	Closure of Pulmonary Valve
	K354	Percutaneous Transluminal Pulmonary Valvotomy
	K356	Percutaneous Transluminal Pulmonary Valve Perforation And Di

MR Patient Exclusions - Based on Operation Codes		
Procedure Type	**OPCS Code**	**Operation Description**
Pulmonary valve surgery	K356	Percutaneous Transluminal Pulmonary Valve Perforation And Di
	K357	Percutaneous Transluminal Pulmonary Valve Replacement
	K362	Pulmonary Valvectomy
Mitral commissurotomy	K311	Open Mitral Valvotomy
	K321	Closed Mitral Valvotomy
	K351	Percutaneous Transluminal Mitral Valvotomy
By OPCS code at 3 character level		
Interatrial septal closure procedures	K09	Repair of Defect of Atrioventricular Septum
	K10	Repair of Defect of Interatrial Septum
	K11	Repair of Defect of Interventricular Septum
	K12	Repair of Defect of Unspecified Septum of Heart
	K13	Transluminal Repair of Defect of Septum
	K14	Other open operations on Septum of Heart
	K15	Closed operations on Septum of Heart
	K16	Other Therapeutic Transluminal Operations on Septum of

Resources

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Resources

Estimated population with moderate/severe MR age ≥65 years in mid 2022 by Integrated Care Board (ICB)[11,12]

ICB Name	Estimated population with MR Mid-2022
England	3,72,048
NHS Bath and North East Somerset, Swindon and Wiltshire Integrated Care Board	6,726
NHS Bedfordshire, Luton and Milton Keynes Integrated Care Board	5,459
NHS Birmingham and Solihull Integrated Care Board	6,925
NHS Black Country Integrated Care Board	7,393
NHS Bristol, North Somerset and South Gloucestershire Integrated Care Board	5,927
NHS Buckinghamshire, Oxfordshire and Berkshire West Integrated Care Board	11,289
NHS Cambridgeshire and Peterborough Integrated Care Board	5,796
NHS Cheshire and Merseyside Integrated Care Board	17,967
NHS Cornwall and The Isles of Scilly Integrated Care Board	5,173
NHS Coventry and Warwickshire Integrated Care Board	6,168
NHS Derby and Derbyshire Integrated Care Board	7,802
NHS Devon Integrated Care Board	10,578
NHS Dorset Integrated Care Board	7,088
NHS Frimley Integrated Care Board	4,388
NHS Gloucestershire Integrated Care Board	5,006
NHS Greater Manchester Integrated Care Board	16,149
NHS Hampshire and Isle of Wight Integrated Care Board	13,643
NHS Herefordshire and Worcestershire Integrated Care Board	6,683
NHS Hertfordshire and West Essex Integrated Care Board	9,259

ICB Name	Estimated population with MR Mid-2022
NHS Humber and North Yorkshire Integrated Care Board	13,549
NHS Kent and Medway Integrated Care Board	13,056
NHS Lancashire and South Cumbria Integrated Care Board	12,745
NHS Leicester, Leicestershire and Rutland Integrated Care Board	7,237
NHS Lincolnshire Integrated Care Board	6,451
NHS Mid and South Essex Integrated Care Board	8,252
NHS Norfolk and Waveney Integrated Care Board	9,132
NHS North Central London Integrated Care Board	6,243
NHS North East and North Cumbria Integrated Care Board	22,101
NHS North East London Integrated Care Board	7,042
NHS North West London Integrated Care Board	9,486
NHS Northamptonshire Integrated Care Board	4,936
NHS Nottingham and Nottinghamshire Integrated Care Board	7,606
NHS Shropshire, Telford and Wrekin Integrated Care Board	4,126
NHS Somerset Integrated Care Board	5,078
NHS South East London Integrated Care Board	7,559
NHS South West London Integrated Care Board	7,141
NHS South Yorkshire Integrated Care Board	9,050
NHS Staffordshire and Stoke-On-Trent Integrated Care Board	8,519
NHS Suffolk and North East Essex Integrated Care Board	8,078
NHS Surrey Heartlands Integrated Care Board	7,057
NHS Sussex Integrated Care Board	13,677
NHS West Yorkshire Integrated Care Board	14,508

The population with MR has been estimated by applying the adjusted prevalence benchmark from the Heart article by Cahill TJ, Prothero A, Wilson J, et al (2021) "Community prevalence, mechanisms and outcome of mitral or tricuspid regurgitation".[12] In this article, the estimated community prevalence of moderate or greater MR within adults aged 65+ is 3.5%. This has been applied to ONS population estimates.[11]

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