Triggering of acute myocardial infarction by respiratory infection

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Abstract

Background: Respiratory infection has been associated with an increased short-term risk of myocardial infarction (MI). However, previous studies have predominantly been conducted without angiographic confirmation of MI. The possibility can therefore not be excluded that raised troponin levels or electrocardiogram abnormalities that may be seen with respiratory infections are due to non-ischaemic causes.
Aims: To investigate the association between respiratory infection and angiographically confirmed MI.
Methods: Interviews were conducted within 4 days of hospitalisation in 578 patients with angiographically confirmed MI, to assess for recent exposure to respiratory infection symptoms and the usual annual frequency of these symptoms. Using case-crossover methodology, exposure to respiratory infection prior to the onset of MI was compared against the usual frequency of exposure in the past year.
Results: Symptoms of respiratory infection were reported by 100 (17%) and 123 (21%) within 7 and 35 days, respectively, prior to MI. The relative risk (RR) for MI occurring within 1–7 days after respiratory infection symptoms was 17.0 (95% confidence interval (CI) 13.2–21.8), and declined with subsequent time periods. In a subgroup analysis, the RR tended to be lower in groups taking regular cardiac medications. For those who reported milder, upper respiratory tract infection symptoms, the RR for the 1–7-day time period was 13.5 (95% CI 10.2–17.7).
Conclusion: These findings confirm that respiratory infection can trigger MI. Further study is indicated to identify treatment strategies to decrease this risk, particularly in individuals who may have increased susceptibility.

Introduction

There is increasing recognition that myocardial infarction (MI) can be precipitated by a respiratory infection, with evidence indicating that pneumonia, bronchitis and influenza confer an increased transient risk of MI.[1–7] This link may also contribute to the seasonal variation and winter peak of MI.[1] However, much of the research linking respiratory infection to MI has been conducted using general practice records or regional registries without angiographic confirmation of MI.[2–4,7] The absence of angiographic data is an important limitation because elevated troponin and electrocardiogram (ECG) changes may occur in the setting of respiratory infection and myocarditis without MI.[8,9]

Previous studies have also tended to restrict their definition of respiratory infection to lower tract infections.[2–4] Although upper respiratory infections are harder to investigate, being milder, of shorter duration and less likely to result in hospitalisation, they are far more common, so it is important to understand their relationship to MI.[10,11] It is unclear whether patient factors, such as age, prior risk factors and medications modify the risk of MI after infection.

We evaluated these questions in the Triggers and Modifiers of Acute Myocardial Infarction study, a single-site, interview-based evaluation of patients hospitalised in a tertiary referral centre with suspected acute MI. For this analysis, we used case-crossover methodology to quantify the relative risk (RR) of MI after respiratory infection in patients with angiographic confirmation.

Methods

Study population

A total of 891 patients who were admitted to a primary angioplasty centre (Royal North Shore Hospital,

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Sydney, Australia) with suspected MI between 2006 and 2014 provided informed consent, and completed a questionnaire, which included questions designed to assess possible exposure to respiratory infection. Of these patients, 650 provided usual frequency data on respiratory infection as well as the start and finish dates of any recent infection. All patients had blood sampled for cardiac biomarkers and underwent angiography during which thrombolysis in myocardial infarction (TIMI) flow scores were recorded prior to revascularisation by the proceduralist. Inclusion in the present analysis required elevated troponin or CK-MB and the presence of a culprit coronary lesion on angiography. Twelve were excluded because of the absence of raised cardiac biomarkers, and 46 were excluded because of not having an identifiable culprit lesion on angiography, of whom 39 had no significant obstructive coronary artery disease, 2 had coronary dissection and 5 had Takotsubo cardiomyopathy. Fourteen patients were excluded for reporting a recent infection but describing clearly non-respiratory symptoms. Ethics approval for this study was granted by the Local Health District Human Research Ethics Committee.

Data collection

Questionnaires were completed within 4 days of hospital admission, facilitated by a research nurse. The questionnaire was based on the ONSET study,[12] and included demographic information and questions related to possible acute triggers, including respiratory infection. Patients were asked if they experienced a recent 'flu-like illness with fever and sore throat', to describe their symptoms, to document the start and end date of their symptoms. To elicit usual frequency data, patients were then asked to state their 'usual frequency of such an illness', as a nominal value per day, week, month or year. To minimise bias in reporting, both participant and interviewer were not advised of the hypothesised hazard periods or potential modifiers of risk.

Statistical analysis

Participant data were entered into a Microsoft ACCESS 2010 database (Microsoft Corporation 2010, Redmond, WA, USA) and analysed using IBM SPSS Statistics for Windows V21 (IBM Corp, Armonk, NY, USA). The analysis used a case-crossover method which is suitable for analysing the association between transient exposures and acute events.[13] Exposure within a certain interval prior to MI (hazard period) was compared with the usual frequency per year (control period) of that exposure for each patient. These two variables were pooled for each patient as individual strata in a Mantel-Haenszel estimation to calculate an overall incidence rate ratio of observed and expected frequency of respiratory infection prior to MI. Because each patient acts as their own control, adjustment for potential confounding by individual clinical factors is not required.

In the primary analysis, patients were considered to be exposed if they reported sore throat, cough, fever, sinus pain, 'flu-like symptoms' or if they reported a diagnosis of pneumonia or bronchitis during the designated periods. These criteria were designed to capture a wide spectrum of respiratory infections. The incidence of exposure in separate 7-day hazard periods prior to MI (1–7, 8–14, 15–21, 22–28 and 29–35 days) was compared with a control period based on usual frequency of exposure in the prior year assuming a 1-week length of infection. If a patient reported two episodes in the previous year, their exposed time was considered to be 2 weeks and their unexposed time 50 weeks. Patients were counted as being exposed within a hazard period if they reported infection on any day within the period, even if for only 1 day. If a patient reported a recent respiratory infection across multiple 7-day hazard periods, they were considered to be exposed within each of these periods. The RR of MI occurring in each 7-day period after respiratory infection was then calculated. Within the primary analysis, the sample was divided into various subgroups to determine how the RR changed according to patient characteristics. Differences between RR were calculated from the ratio of RR (RRR = Risk1/Risk2), with the risks considered statistically significantly different if the z-score was $< \text{or} > 1.96$ and if the 95% confidence interval (CI) did not cross unity.[14]

As the RR in a case-crossover method is dependent on the designated duration of the hazard period, sensitivity analyses were conducted using hazard periods of 3, 5, 7, 14 and 28 days, as in previous studies.[2–4,6,7] The primary hazard period length that we used, 7 days, was chosen for being in the middle range.

A secondary analysis was conducted to calculate the RR of MI for episodes restricted to those originating from the upper respiratory tract. Such infections include the common cold, pharyngitis, rhinitis and sinusitis. This was based only on reported symptoms and without serological confirmation. Patients were classified as experiencing an upper respiratory infection if they reported symptoms known to be typical for such infections, including 'a cold' or flu-like symptoms, or a dry cough, 'running nose' or sore throat.[15] Patients were excluded from this analysis if they reported pneumonia, chest infection, bronchitis or lower tract symptoms, such as a productive cough and dyspnoea, or being treated with antibiotics.

Results

Subject characteristics are displayed in Table 1. A total of 100 (17%) and 123 (21%) patients reported respiratory infection symptoms within the 7 and 35 days, respectively, prior to MI. The characteristics of the subjects with and without respiratory infection <35 days were similar, other than a relatively higher proportion of women reporting respiratory infection. The average reported usual frequency for the sample was 0.88 infection episodes per year. In the primary analysis (Fig. 1), the RR for MI occurring within 1–7 days of respiratory infection was 17.0 (95% CI 13.2–21.8) and declined over time with each 7-day hazard period (Fig. 1). A sensitivity analysis revealed that these results were consistent across various hazard period lengths (data not shown). As an example, the RR for the 1–14-day hazard period was significantly elevated at 9.5 (95% CI 7.4–25.4).

When dividing patients by coronary flow into those with TIMI 0–1 (closed) and TIMI 2–3 (open), a non-significant trend was seen for a larger RR to be observed in the TIMI 2–3 group (22.5 (15.6–32.5) vs 14.0 (10.0–19.6) for the 1–7-day hazard interval) (Table 2).

Twelve patients reported a recent infection lasting longer than 30 days, in contrast to the majority of the episodes which were less than 14 days (the mean length of a recent infection excluding these 12 patients was 11.1 days). To ensure that our results were not confounded by these patients, we repeated the primary analysis excluding these 12 patients. The calculated RR in this analysis was 16.4 (95% CI 12.7–21.2) for the 1–7-day time period and remained significantly elevated until the 29–35-day period for which the RR was 1.4 (95% CI 0.8–2.4).

Several patient characteristics appeared to modify the RR. The RR point estimate tended to be lower among males versus females, and among patients who reported a previous MI, hypercholesterolaemia or hypertension, or who were taking aspirin, beta blockers or angiotensin-converting enzyme (ACE) inhibitors before their MI (Table 3).

The participants reporting respiratory infection within 35 days were given the opportunity to provide details regarding the infection. Although this information is limited by being self-reported as free text, and without independent verification, the responses among the 123 participants were sore throat (n = 38), cold (n = 26), flu (n = 24), cough (n = 23), chest infection (n = 23), runny nose (n = 7), sinus symptoms (n = 7), fever (n = 6), bronchitis (n = 5), blocked nose (n = 5), current or recent antibiotic use (n = 4) and pneumonia (n = 3).

In a secondary analysis of the 108 patients classified as having an upper respiratory infection, the RR for MI within 1–7 days of infection was lower than in the primary analysis of all respiratory infection, but was elevated at 13.5 (95% CI 10.2–17.7). The RR of MI at prior intervals of upper respiratory infection were: 8–14 days RR 7.4 (5.4–10.2); 15–21 days RR 3.7 (2.5–5.5); 22–28 days RR 1.8 (1.1–3.0) and 29–35 days RR 1.7 (1.0–2.9).

As the exclusion of the 188 patients who did not report a recent infection and failed to provide usual frequency data may have led to an overestimation of the RR, a further analysis was conducted, including these 188 patients, assuming a usual frequency of 0.88 infection episodes per year (the mean for the entire group), and found an elevated RR of 10.9 (95% CI 8.6–13.7). If this subgroup was assumed to have a higher usual frequency of two infections per year, the RR remained elevated (7.4 (95% CI 6.0–9.3) and, if the entire cohort were assumed to have a usual frequency of two infections per year, the RR was 3.8 (95% CI 3.1–4.7).

Discussion

The major finding of this study is that respiratory infection symptoms were associated with a 17-fold increased risk of MI within the following 7 days. This RR gradually lessened but remained elevated 1 month after respiratory infection.

To our knowledge, this is the first study to report an association between respiratory infection and increased MI risk in individual patients with angiographically confirmed MI, as previous studies have relied on ECG data, troponin elevations and symptoms for diagnosis of MI. Our data are supported by findings from the CARDIO-ARSIF registry, of an 8.9% excess in RR of angiographically confirmed STEMI (95% CI 3.2–14.9%) during periods of influenza epidemic.[16] Angiographic confirmation is important as viral and bacterial pathogens may directly damage myocardial tissue, with troponin elevations being reported in 43% of septic patients.[17] In patients with community-acquired pneumonia, Cangemi and colleagues detected Troponin T elevations in 52% of subjects, whereas only 11% were subsequently diagnosed with MI.[9] In one study of patients with recent pneumonia without a history of CVD, abnormal QRS morphology was seen in 39%, and non-specific ST segment and T wave abnormalities in 21% of patients.[8] These data indicate that relying on ECG and troponin data to diagnose accurately MI in patients with respiratory infection may lead to misclassification of patients and exposures.

Our results add to the growing evidence that respiratory infection is associated with an increased transient risk of MI.[2–4,6,7] The magnitude of the increased risk has

Table 1 Sociodemographic factors and angiography data

	All patients (n = 578)	Respiratory infection <35 days (n = 123)	No respiratory infection <35 days (n = 455)
Age (years) mean ± SD	59.5 ± 12.8	56.4 ± 12.5	60.5 ± 12.8
BMI (kg/m^2) mean ± SD	27.8 ± 5.1	27.5 ± 5.1	28 ± 5.1
	n (%)	n (%)	n (%)
Gender			
Male	484 (84)	96 (78)	388 (85)†
Female	94 (16)	27 (22)	67 (15)
Medical history			
Hypertension	271 (47)	51 (41)	220 (48)
Hypercholesterolaemia	280 (48)	59 (48)	221 (49)
Diabetes	87 (15)	19 (15)	68 (15)
Prior MI	82 (14)	15 (12)	67 (15)
Prior CABG	39 (7)	7 (6)	32 (7)
Prior PCI	60 (10)	12 (10)	48 (11)
Prior cerebrovascular event	20 (3)	3 (2)	17 (4)
Peripheral vascular disease	33 (6)	9 (7)	24 (5)
Renal Disease	26 (4)	5 (4)	21 (5)
Prior medications			
Beta blockers	53 (9)	11 (9)	42 (9)
Aspirin	91(16)	16 (13)	75 (16)
Other anti-platelet	35 (6)	8 (7)	27 (6)
Dihydropyridine CCB	37 (6)	8 (7)	29 (6)
Non-dihydropyridine CCB	9 (2)	1 (1)	8 (2)
ACEI/ARB	155 (27)	26 (21)	129 (28)
Statin	108 (19)	22 (18)	86 (19)
Nitrate	13 (2)	1 (1)	12 (3)
Loop diuretic	11 (2)	2 (1)	9 (2)
Thiazide	14 (2)	4 (3)	10 (2)
Smoking status			
Current	209 (36)	51 (41)	158 (35)
Ex-smoker	161 (28)	36 (29)	125 (27)
Never smoked	208 (36)	38 (17)	170 (37)
Number vessel disease			
Single vessel disease	292 (51)	72 (59)	220 (48)
Multi-vessel disease	286 (49)	51 (41)	235 (52)
Flow in culprit artery			
TIMI flow 0–1 (closed)	320 (55)	67 (54)	253 (56)
TIMI flow 2–3 (open)	258 (45)	56 (46)	202 (44)
Calendar season of recruitment to study			
Summer	150 (26)	26 (21)	124 (27)
Autumn	140 (24)	24 (20)	116 (25)
Winter	152 (26)	44 (36)	108 (24)
Spring	136 (24)	29 (24)	107 (24)

†Significant difference for subjects with or without recent respiratory infection $P < 0.05$. ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin-receptor blocker; BMI, body mass index; CABG, coronary artery bypass graft; CCB, calcium-channel blocker; MI, myocardial infarction; PCI, percutaneous coronary intervention; PVD, peripheral vascular disease; SD, standard deviation; TIMI, thrombolysis in myocardial infarction flow grade.

varied in prior studies, possibly due in part to how respiratory infection was classified. For example, Dalager and colleagues observed a large RR of 32 for MI in 30 days after serologically confirmed bacteraemia of respiratory origin,[7] supporting our finding that the increased RR of MI remains elevated up to 1 month after respiratory infection. In contrast, a recent meta-analysis of case–control studies found that an influenza-like illness was associated with a doubling of MI risk (odds ratio (OR) 2.29, 95% CI 1.11–4.73), with serologically confirmed influenza having a similar increased OR (OR 2.44, 95% CI 0.83–7.20).[18] In our study, we used self-reported patient data to classify respiratory symptoms. This ensured a wide range of respiratory infections would be included, such as pneumonia, bronchitis, influenza as well as upper respiratory tract infections.

We classified patients into lower and upper respiratory tract infection groups based on self-reported symptoms

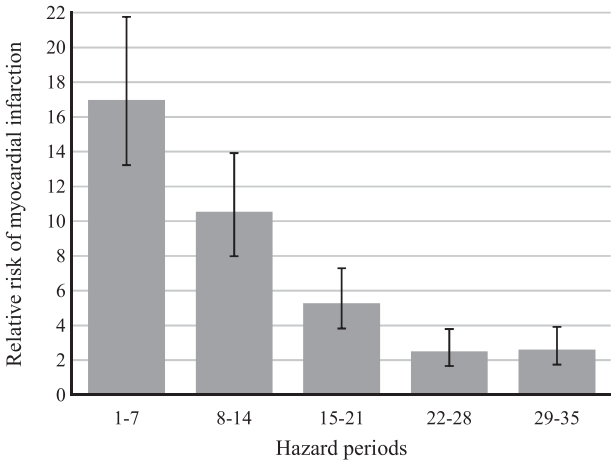

Figure 1 Relative risk for myocardial infarction in 7-day hazard periods after respiratory infection. Error bars indicate 95% confidence interval.

Table 2 Relative risk (RR) of respiratory infection triggering myocardial infarction in 7-day hazard periods for TIMI 0–1 (n = 320) and TIMI 2–3 (n = 258) groups

Hazard period	TIMI 0–1 RR (95% CI)	TIMI 2–3 RR (95% CI)
1–7	14.0 (10.0–19.6)	22.5 (15.6–32.5)
8–14	8.5 (5.8–12.4)	14.5 (9.6–22.0)
15–21	3.8 (2.4–5.9)	8.6 (5.3–13.9)*
22–28	2.3 (1.4–3.8)	3.0 (1.5–5.9)
29–35	2.6 (1.6–4.3)	3.0 (1.5–5.9)

*P < 0.05 Test of interaction (z-score) = −2.43 (95% CI 0.23–0.85). CI, confidence interval; TIMI, thrombolysis in myocardial infarction flow grade.

considered to be typical for each group.[15] When including only patients reporting upper respiratory tract symptoms, infection was associated with a 13.5-fold increase in MI risk. Prior evidence for increased MI risk after upper respiratory tract symptoms is limited, although Spodick reported a doubling of MI risk in association with similar self-reported symptoms.[19] Although upper respiratory tract symptoms are less severe, they are far more common than lower respiratory tract symptoms. A recent national survey conducted in Australian cities estimated that approximately 68.9 million episodes of the common cold or 'flu' occur within the Australian population each year.[11] For people aged 40 years and older, the average incidence was between one and three episodes per person per year.[11] With upper respiratory tract infections occurring so frequently, our finding that such episodes may transiently increase MI risk may be particularly significant from a public health perspective. Other Australian studies include a case-crossover study conducted in Adelaide, which reported a 6.8-fold increased risk of MI in the 1–7 days after self-reported

Table 3 Relative risk (RR) of myocardial infarction in the 1–7-day hazard period, for patient subgroups

Subgroup	RR	95% CI
Age (years)		
<60	16.1	11.6–22.4
>60	18.4	12.6–26.8
Gender		
Male	15.2	11.6–20.1
Female	27.1	15.0–48.7
BMI		
Normal (<25 kg/m^2)	21.9	14.3–33.6
Overweight (≥25 kg/m^2)	17.1	12.3–23.7
Previous MI		
Yes	9.9	5.0–19.7
No	18.5	14.1–24.2
Hypertension		
Yes	14.5	9.9–21.2
No	19.1	13.7–26.6
Hypercholesterolaemia		
Yes	14.6	10.1–21.0
No	19.6	14.0–27.6
Diabetes		
Yes	15.2	8.1–28.3
No	17.1	13.1–22.5
Previous CABG		
Yes	11.2	3.7–33.4
No	17.4	13.5–22.5
Beta blockers		
Yes	10.8	5.2–22.3
No	17.8	13.6–23.2
Aspirin		
Yes	12.9	6.6–25.3
No	17.6	13.5–23.0
Anti-platelet agents		
Yes	12.4	6.9–22.6
No	18.0	13.7–23.7
ACEI/ARB		
Yes	10.2	5.6–18.4*
No	19.8	15.0–26.0
Statin		
Yes	13.4	7.4–24.3
No	18.1	13.7–23.8
Smoking status		
Current	18.0	12.6–25.5
Never/Ex	16.2	11.5–23.0

*P < 0.05 Test of interaction (z-score) = −1.98 (95% CI 0.27–0.99). ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin-receptor blocker; BMI, body mass index; CABG, coronary artery bypass graft; CI, confidence interval; MI, myocardial infarction.

infection.[20] A case–control study conducted within Sydney did not find a significant association between serological influenza detection and MI but did observe a protective role for influenza vaccination.[21]

Several mechanisms have been proposed to explain why respiratory infection may increase MI risk.[22–24] Infection can activate platelets and the coagulation system, leading to a prothrombotic environment. Bacterial pathogens have

been reported to bind, both directly and indirectly, to platelets and increase both their activity and aggregation.[25] Markers of platelet activity have been associated with MI in patients with community-acquired pneumonia.[9] Increased platelet activity and pro-inflammatory markers have also been observed in patients with typical upper respiratory tract viral infections,[26] while increased coagulation activity has been observed in pneumonia, including those with mild disease.[27] Influenza and community-acquired pneumonia give rise to a systemic inflammatory response associated with increases in TNFα, IL1b and IL6 and other pro-inflammatory cytokines.[22,24] Raised cytokine levels may persist after the resolution of the clinical signs of the infection, helping to explain the increased MI risk up to several weeks after a respiratory tract infection. Pathogens may also have a more direct effect on atherosclerotic plaque cells. Macrophage activation and differentiation of T helper lymphocytes may promote plaque destabilisation and macrophage apoptosis may contribute to a necrotic core.[22,24] Infection can also result in increasing catecholamines and potentially adverse haemodynamic effects, such as peripheral vasodilatation, coronary vasoconstriction, increased myocardial metabolic demands, hypoxia and volume shifts, and worsening or new onset arrhythmias.[28] In the present study, the RR of respiratory infection was elevated in patients with TIMI flow scores of both 0–1 and 2–3; however, it tended to be higher in the TIMI 2–3 group, suggesting that the elevated MI risk after respiratory infection may in some instances be associated with increased myocardial oxygen demand rather than solely plaque rupture and thrombosis.

Potential measures to prevent or attenuate the MI risk after respiratory infection include reducing exposure to infection,[15] and influenza and pneumococcal vaccinations.[21,29] A recent meta-analysis found a 29% risk reduction for influenza vaccination against MI.[18] Once a person is exposed to respiratory infection, secondary prevention methods may include prompt treatment of the infection as well as possibly taking aspirin to reduce the transient increase in CVD risk.[30,31] We found that the RR of MI after respiratory infection tended to be lower in patients taking aspirin, statins, beta blockers and ACE inhibitors, suggesting that these medications may play a protective role at the time of infection, with statistical significance ($P < 0.05$) for ACE inhibitors. However, this was a univariate analysis only, and more detailed study is required to determine which clinical factors may modify the infection risk. Aspirin use has been associated with lower mortality rates in patients with pneumonia,[32] and because platelet activation occurs with pneumonia, a preventive role for aspirin is biologically plausible. Statins have also been shown to possess anti-thrombotic and anti-inflammatory effects and have been associated with reduced mortality after pneumonia.[33–35] ACE inhibitors may improve endothelial function,[36] while beta blockers may potentially reduce tachycardia during respiratory infection. Patients who develop a respiratory infection should not dismiss chest pain symptoms as necessarily respiratory and not cardiac in origin. It is important to note that our findings identify an increased RR, rather than absolute risk. Patients with an already elevated baseline CVD risk are likely to derive the most benefit from prevention strategies, while for those at low baseline risk, the incremental increase in absolute risk would be very small.

The strengths of our study include the presence of angiographically confirmed MI, as well as the case-crossover methodology. Case-crossover and case-series methods have been relatively underutilised[3,6,20,37] with most prior studies being based on case–control or cohort methods.[2,4,7,10,18,19] Patient recruitment equally occurred throughout the calendar year, and was not restricted to the winter months, when respiratory infections are more common, which would have overestimated the risk.

Study limitations include the absence of serologic confirmation of infection or independent correlation of the symptoms. Vaccination status was also not known, and it is possible that the lower RR observed among patients with CVD risk factors or taking cardioprotective medication was due in part to their being more likely to have received influenza vaccinations. We excluded cases with missing details regarding infection dates, symptoms or those with no recent infection who failed to provide usual frequency data. Since exclusion of the 188 patients who fell into this latter category may have led to an overestimation of the calculated RR, further analyses were conducted, including these 188 patients, firstly assuming a usual frequency of 0.88 infection episodes per year (the mean for the entire group), and then assuming a higher usual frequency of two episodes per year in accordance with previously reported data,[11] and found a still significantly elevated RR. To exclude recall bias further, we conducted an additional analysis assuming that the entire cohort had a usual frequency of two infection episodes per year, and the RR still remained elevated. Participants could not be blinded from knowing the trigger under investigation; however, this was unlikely to have had a significant impact as none of the patients attributed their MI to the prior respiratory infection. This indicates a lack of awareness in the wider community of respiratory infection as an acute trigger of MI.

Conclusion

This angiographic-based study confirms that respiratory infection is an acute trigger of MI. The finding

that MI risk may be reduced in certain subgroups supports the need for further investigation into the causative mechanisms and the role that medications may play in the development of acute risk prevention strategies.

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Development of a peer-review framework for cancer multidisciplinary meetings

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multidisciplinary team meetings, multidisciplinary cancer care, peer review, accreditation, quality improvement.

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Abstract

Background: There is no mechanism in place for monitoring or quality improvement of cancer multidisciplinary meetings (MDM) in Australia.
Aim: To develop a peer-review process for quality improvement of MDM.
Methods: This project involved three phases: (i) development of a draft peer-review framework, supporting documents and peer-review process; (ii) consultation with key stakeholders; (iii) refinement of the framework, documents and processes following a pilot study with three MDM.
Results: Feedback indicated that specific standards included in the framework needed to allow the peer reviewers to be flexible relative to the circumstances of the individual MDM. Conversely, feedback identified the need for clear, evidence-based clinical practice guidelines for the conduct of MDM, with accepted standards and objective measures of performance. MDM members were divided about the need to employ peer reviewers from the tumour stream of the MDM under review but agreed that closer involvement of the team under review to support the implementation of recommendations is warranted.
Conclusions: We developed an adaptable peer-review framework and process using the current available evidence and guidance. While further research is needed to establish what constitutes best practice in MDM and which processes contribute to improved patient outcomes, the structured peer-review process we describe, when modified using the disease-relevant evidence, could be utilised more broadly as a quality improvement tool.

Introduction

Multidisciplinary cancer care, regarded as best practice in cancer[1,2] is defined as '…an integrated team approach to healthcare in which medical and allied healthcare professionals consider all relevant treatment options and develop collaboratively an individual treatment plan for each patient.'[3] While patient care may be discussed by multiple professionals in informal settings, multidisciplinary team meetings (MDM) are the only time/place where patients' management is formally discussed and documented by different health professionals.[4] When implemented successfully, MDM result in improved

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