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Reducing hospital admissions in patients with malignant pleural effusion: a quality improvement study

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ABSTRACT

Background Malignant pleural effusions (MPE) can cause severe dyspnoea leading to greater than 125 000 hospitalisations per year and cost greater than US$5 billion per year in the USA. Timely insertion of tunnelled pleural catheters (TPCs) is associated with fewer inpatient days and emergency department visits. We conducted a quality improvement study to reduce hospital admissions of patients with MPE.

Methods Key stakeholders were surveyed, including thoracic and breast oncology teams, general pulmonary and interventional pulmonology (IP) to help identify the underlying causes and solutions. Our preintervention group consisted of 51 patients who underwent TPC placement by our IP service. In our first intervention, we reviewed referrals for MPE with the scheduling team and triaged them based on urgency. In the second intervention, we added a follow-up phone call 1 week after the initial thoracentesis performed by IP to assess for the recurrence of symptoms.

Results Demographic and clinical characteristics were summarised across the three groups. We evaluated the rate ratio (RR) of admissions in the intervention groups with the multivariable Poisson regression and adjusted for race, gender and cancer. Compared with the preintervention group, intervention I showed trends towards a 41% lower hospital admission rate (RR 0.59 (0.33–1.07), p=0.11). Compared with the preintervention group, intervention II showed trends towards a 40% lower hospital admission rate (RR 0.6 (0.36–0.99), p=0.07). The results did not reach statistical significance. Exploratory comparisons in readmission rates between interventions I and II showed no difference (RR 0.89 (0.43–1.79), p=0.75).

Conclusions Both interventions showed trends toward fewer hospital readmissions although they were not statistically significant. Larger-size prospective studies would be needed to demonstrate the continued effectiveness of these interventions.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Malignant pleural effusions (MPE) lead to many hospital admissions due to disabling dyspnoea and the necessary procedures that ensue. This quality improvement project was performed to determine if we could identify strategies to decrease hospital admissions in this population.

WHAT THIS STUDY ADDS

⇒ Our interventions included reviewing new referrals for urgency and phone follow-up 1 week post thoracentesis. These interventions led to trends toward reduced hospital admissions in our study.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This knowledge may positively impact practice patterns and may inform future multicentre studies that implement changes to help prevent unnecessary hospital admissions for MPE, which are costly and may negatively impact the quality of life.

INTRODUCTION

Problem description

Malignant pleural effusions (MPE) frequently present with progressive dyspnoea, which can lead to frequent emergency department (ED) visits and hospitalisations. Outpatient interventions could potentially prevent a significant number of these visits. In this quality improvement (QI) project, we evaluated if pre-emptive communication and development of a definitive therapeutic plan prior to pleural fluid recurrence could prevent recurrent hospitalisations.

Available knowledge

It is estimated that patients with MPEs account for roughly 125 000 hospitalisations every year in the USA and approximately US$5 billion are spent every year on their management.[1] Recurrent MPE requires evacuation of pleural fluid for symptom palliation through procedures such as repeated thoracentesis, tunnelled pleural catheters (TPCs), chest tube pleurodesis or thoracoscopic pleurodesis.[2] Overall, 58% of patients with MPE experience rapid recurrence even after thoracentesis[2] and the number is higher for lung cancer, breast cancer and lymphoma.[3] The average hospital length of stay for MPE is 5 days.[4] One in four patients with MPE is

readmitted to the hospital within 30 days of discharge if thoracentesis alone was used as the primary modality for drainage.[5] Furthermore, lack of symptom palliation and recurrent hospitalisation is associated with lower quality of life (QOL).[6]

The insertion of TPCs is a first-line treatment for symptom palliation. They can be placed in an outpatient setting and reduce the need for further invasive procedures for pleural fluid evacuation. Their use can lead to a reduction in pleural interventions, ED visits, 30-day readmissions and rate of complications such as pneumothorax.[2 4] Several studies have demonstrated that draining these pleural effusions improved symptoms, particularly dyspnoea.[7–9] TPCs also improved QOL and reduced the number of healthcare visits.[10 11] They also have shown cost-effectiveness compared with other modalities for patients with limited life expectancy.[12]

Specific aims and rationale

The goal of this QI project was to reduce preventable hospital admissions related to the management of MPE. We hypothesised that the timely outpatient triaging of referrals, interventions and postprocedural follow-up phone communication would reduce the hospital admission rate for MPE by more than 20% over a period of 9 months.

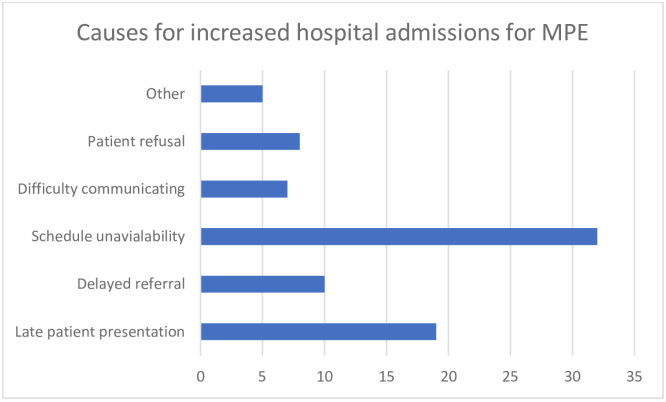
METHODS

We used the Define, Measure, Analyze, Improve, and Control (DMAIC) improvement cycle tool to guide our study processes.[13] The manuscript has been written using the Standards for Quality Improvement Reporting Excellence guidelines (SQUIRE).[14] This QI project was submitted to the institutional review board (IRB) and received an IRB exemption; this publication was an internal QI study and this is a factual account of the project. REDCap which was created in 2004 by Vanderbilt University as Health Insurance Portability and Accountability Act(HIPAA)-compliant server was used to administer the surveys, collect data and analyse results.[15] We had no internal or external funding sources and none of the authors had any conflicting interests.

Context

The Ohio State University Wexner Medical Center is a large tertiary care academic centre. It has 1497 beds; 356 of which are James Cancer Hospital beds. There are approximately 58 320 inpatient admissions, 112 995 ED visits and 2.25 million outpatient visits per year.[16]

The Interventional Pulmonary (IP) group is comprised of four attending physicians, a physician IP fellow and two advanced practice providers (APPs). Dedicated thoracic clinic nurses support the outpatient centre and dedicated respiratory therapists and nurses support the procedure suite. The physicians perform both thoracentesis and TPC placement, while the APPs perform thoracentesis and outpatient follow-up of patients with TPCs. Home care and supplies for patients needing TPCs are coordinated through the thoracic oncology centre. The bronchoscopy suite is used to support the procedures. The IP team evaluates and manages approximately 350 outpatient clinic visits per month, 120 inpatients per month, 200–250 procedures per month, 10–15 thoracentesis per month and 10–12 TPCs per month. Most of the patients that the IP team cares for have known malignancy or imaging findings suspicious for cancer. The IP team is also part of a multidisciplinary team with thoracic medical oncologists, radiation oncologists and thoracic surgeons with a close collaboration in the clinics as well as through weekly tumour board discussions.



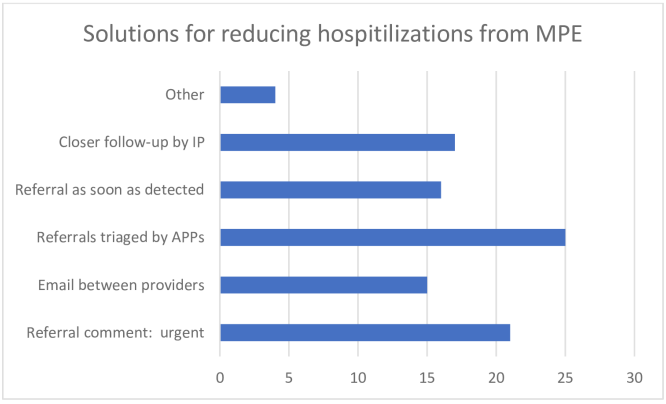


Figure 1 Results from preintervention survey. APPs, advanced practice providers; IP, Interventional Pulmonary; MPE, malignant pleural effusions.

Interventions & Measures

The preintervention population was collected by retrospectively searching patients who underwent TPC placement for MPE by the IP team both inpatient and outpatient between 1 October 2020 and 31 March 2021 (n=51).

We surveyed stakeholders who contribute to the management of MPE at our institution which include members of the IP team, referring physicians, clinic and procedural nurses and respiratory therapists (online supplemental appendix 1). The survey assessed referral reasons, teams referred to, satisfaction with the current processes, causes of delays (figure 1) and timeliness of pleural interventions. We based our interventions on the two most frequent suggestions from the surveys, which included triaging new patients appropriately and

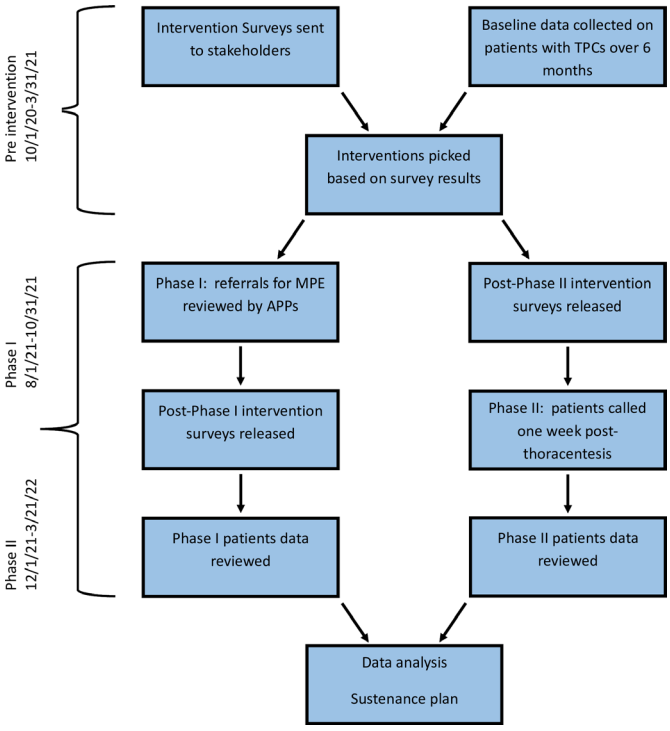


Figure 2 Project flow diagram. APPs, advanced practice providers; MPE, malignant pleural effusions; TPCs, tunnelled pleural catheters.

performing closer follow-ups after thoracentesis. The surveys were anonymous, completely voluntary and with no financial incentive. The key stakeholders were surveyed before and after each intervention for their level of satisfaction, timeliness and criteria for referral (online supplemental appendixs 2 and 3).

Our first intervention consisted of providers triaging all new outpatient referrals to prioritise patients needing urgent interventions. Patients were scheduled urgently when an imaging of the chest demonstrated pleural fluid greater than one-third of the hemithorax, they had worsening dyspnoea or had chest discomfort. The intervention I group consisted of patients referred to our outpatient service between 1 August 2021 and 31 October 2021 (n=30). We collaborated with our scheduling team to coordinate this process with the APPs.

The second intervention (1 December 2021 to 15 May 2022 (n=23)) involved contacting inpatients and outpatients 1 week after the first thoracentesis by IP to assess their symptoms to guide decisions on performing earlier interventions. Clinic nurses and APPs evaluated their dyspnoea scores on the Borg scale[17] and compared it to their Borg scores before and immediately following thoracentesis. The key stakeholders were surveyed before and after each intervention for their level of satisfaction, timeliness and criteria for referral (size of effusion and patient symptoms). Detailed steps of the entire process are covered in figure 2.

Analysis

Clinical characteristics were summarised using descriptive statistics. Categorical variables were summarised as frequencies and percentages. Continuous variables were summarised as median with IQR (25th percentile and 75th percentile). Multivariate Poisson regression was used to estimate the effect of interventions on rate of admission. The regression analyses were adjusted by race, gender and cancer type. Statistical analyses were performed using R software (V.4.2.2; R Core Team, R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Details of the process measures and outcomes

Qualitative results (survey results)

In total, 45 stakeholders filled out the baseline survey out of 122 surveyed (response rate: 37%). At baseline, 56% of respondents reported a satisfaction score of more than or equal to 4/5 for timeliness of thoracentesis and 53% of responded reported a satisfaction score of more than or equal to 4/5 for timeliness of TPC (1 being least satisfied and 5 most satisfied). The most frequently cited cause of delayed referrals was scheduling delays (74%) and late clinical presentation (44%). Most stakeholders refer when the patients are symptomatic and have a large pleural effusion at 37%. They refer to the IP physicians 72% of the time and usually place consultations to multiple services for first available appointments. More than 65% of respondents felt that excess hospital admissions could be avoided.

As shown in figure 1, having a dedicated APP to triage new referrals was the most common recommendation (60%). The second most recommended intervention was that the ordering provider should leave a referral order comment stating the urgency for scheduling (50%) which was already in place. The next highest intervention recommended closer follow-ups after initial thoracentesis by the IP service (40%).

The second survey was conducted after completion of intervention I for the respondents of the baseline survey. We had 22 responses out of 45 (response rate 49%). There was 86% satisfaction with more than or equal to 4/5 score with the timeliness of interventions for MPE. More than half of the respondents (55%) still felt that excess hospital admissions could be avoided. Overall, 40% of respondents noted some improvement and 40% noted significant improvement.

The next survey was conducted after the completion of intervention II for the respondents of the baseline survey. We had 13 respondents (response rate 29%). Overall, 50% of respondents noted some improvement and 25% of respondents noted significant improvement.

Quantitative results

Adult patients with MPE from 1 October 2020 to 15 May 2021 were included for our QI project. Vulnerable populations were excluded (prisoners, pregnant women and

patients less than 18 years old). Hospital admissions were calculated based on admissions for MPE and admissions for pneumonia, failure to thrive or other causes were excluded.

A total of 104 participants were included in the study. There were 51 patients in the preintervention group, 30 patients in intervention I and 23 patients in intervention II. The preintervention group had more referrals from inpatient providers: 76% in the preintervention group, 33% in intervention I and 22% in intervention II. The majority of the thoracentesis and TPCs were inserted in the inpatient setting in the preintervention groups (61% and 77%, respectively). Most of the thoracenteses and TPCs were performed in the outpatient setting in both intervention groups: intervention I had 71% of thoracentesis and 48% of TPCs done in the outpatient setting while intervention II had 82% of thoracentesis and 70% of TPCs done in the outpatient setting. There were 13 patients in intervention I and 12 patients in intervention II that did not require a TPC due to fluid resolution and patient mortality (table 1).

Table 1 Demographics

Characteristic	Preintervention (n=51)	Intervention I (n=30)	Intervention II (n=23)
Gender, n (%)			
Female	30 (59%)	15 (50%)	14 (61%)
Male	21 (41%)	15 (50%)	9 (39%)
Age (years), median (IQR)	64 (52–73)	67 (62–75)	66 (57.50–71.50)
Cancer type, n (%)			
Breast	10 (20%)	2 (6.9%)	2 (8.7%)
Gastrointestinal	3 (5.9%)	4 (14%)	1 (4.3%)
Genitourinary	6 (12%)	0 (0%)	1 (4.3%)
Lung	25 (49%)	15 (52%)	16 (70%)
Other	7 (14%)	8 (28%)	3 (13%)
Missing	0	1	0
Race, n (%)			
Black	11 (22%)	2 (6.7%)	2 (8.7%)
Other	1 (2.0%)	2 (6.7%)	3 (13%)
White	39 (76%)	26 (87%)	18 (78%)
Insurance, n (%)			
Medicaid	3 (6.2%)	1 (3.3%)	2 (8.7%)
Medicare	25 (52%)	15 (50%)	11 (48%)
No insurance	2 (4.2%)	0 (0%)	0 (0%)
Third party	18 (38%)	14 (47%)	10 (43%)
Missing	3	0	0
Referral source, n (%)			
Inpatient	37 (76%)	10 (33%)	5 (22%)
Oncology	0 (0%)	0 (0%)	1 (4.3%)
Outpatient	10 (20%)	20 (67%)	17 (74%)
Outpatient other	2 (4.1%)	0 (0%)	0 (0%)
Missing	2	0	0
Tunnelled pleural catheter location, n (%)			
Inpatient	31 (61%)	5 (29%)	2 (18%)
Outpatient	20 (39%)	12 (71%)	9 (82%)
Missing	0	13	12
Thoracentesis location, n (%)			
Inpatient	36 (77%)	15 (52%)	7 (30%)
Outpatient	11 (23%)	14 (48%)	16 (70%)
Missing	4	1	0

Table 2 Multivariate Poisson regression model result

	Intervention I (n=30)		Intervention II (n=23)	
	RR (95% CI)	P value	RR (95% CI)	P value
Group				
Preintervention (n=51)	Reference		Reference	
Intervention	0.59 (0.3 to 1.09)	0.11	0.6 (0.33 to 1.03)	0.07
Cancer type				
Breast	Reference		Reference	
Gastrointestinal	0.79 (0.18 to 2.57)	0.72	1.03 (0.3 to 3.15)	0.97
Genitourinary	1.1 (0.41 to 2.78)	0.84	1.78 (0.63 to 4.92)	0.26
Lung	0.69 (0.33 to 1.51)	0.34	1.25 (0.57 to 3.03)	0.59
Other	1.75 (0.76 to 4.1)	0.19	2.06 (0.85 to 5.31)	0.12
Race				
Black	Reference		Reference	
Other	0.87 (0.13 to 3.49)	0.86	1.63 (0.34 to 5.97)	0.49
White	1.08 (0.57 to 2.24)	0.82	0.88 (0.49 to 1.72)	0.7
Gender				
Female	Reference		Reference	
Male	1.02 (0.6 to 1.8)	0.96	1 (0.61 to 1.67)	0.99

The preintervention group consisted of 59% women, while intervention I had 50% women and intervention II had 61% women. The median age for all three groups ranged from 64 to 67 years old, and all groups had a majority of patients with lung cancer, Caucasian race and Medicare insurance (table 1).

We evaluated the rate ratio (RR) of admissions in the intervention groups compared with the preintervention group, controlling for race, gender, race and cancer type (table 2). Compared with the preintervention group, intervention I showed trends towards a 41% lower hospital admission rate (RR 0.59 (0.33–1.07), p=0.11). Compared with the preintervention group, intervention II showed trends towards a 40% lower hospital admission rate (RR 0.6 (0.36–0.99), p=0.07).

In intervention I, 43% of patients had at least one admission and 10% had two or more admissions. In intervention II, 22% of patients had at least one admission and 17% had two or more admissions.

To further compare admission rate between intervention groups, exploratory comparisons in readmission rates between interventions I and II showed no difference (RR 0.89 (0.43–1.79), p=0.75).

Unintended consequences

There was significant time invested by the APPs involved in triaging new referrals and follow-up phone calls in intervention I, sometimes requiring additional nursing support from our clinic nurses, which can be difficult when short-staffed.

Contextual elements that interacted with the intervention(s) and observed associations and missing data

Some factors that interacted with our interventions were communication challenges when the reason for referral was not accurately stated, leading to some missed referrals. The reasons for delayed TPC insertion were not always clear in the preintervention group.

DISCUSSION

Summary and interpretation

In this QI study, we evaluated two interventions to reach a goal of 20% reduction in hospital readmission rate. Intervention I included triaging all referrals for MPE to our service with providers, intervention II included scheduled additional phone call follow-up with patients 1 week after thoracentesis to evaluate for recurrence of symptoms and need for TPC. Both interventions showed trends toward fewer hospital readmissions, although they were not statistically significant.

This study subject is important since admissions and readmissions for patients with MPE are high and at least 25% of MPE patients are readmitted within 30 days of discharge, particularly if thoracentesis was performed rather than TPC or pleurodesis.[1 5]

Intervention I consisted of IP APPs receiving new referrals from the scheduling in order to triage them based on urgency of their symptoms and imaging. This process enabled 16 patients to receive more timely appointments. We saw trends towards decreased hospital admission rates with this intervention. However, the difference did not reach statistical significance. Prior studies have

demonstrated improvement in seeing patients sooner and patient satisfaction when triaging patients appropriately with clinical staff.[18 19]

Intervention II involved nurses and APPs calling patients 1 week after thoracentesis with the Borg scale in order to see if they needed intervention sooner than when they are usually scheduled which is at least 2–4 weeks out. This phone call led to earlier intervention or appointment then planned in nine of the patients. We saw trends towards decreased hospital admission rates with this intervention as well. However, the difference did not reach statistical significance either. This is similar to a study done with nurses calling patients after neurosurgery in which half of patients had improvement in safety because they were told what concerning symptoms to look for, when to call and when to seek emergency care.[20]

We observed that more procedures were performed while outpatient in the preintervention group as compared with the intervention I and intervention II groups. MPE is a common diagnosis on readmissions and many procedures for MPE are performed in the hospital because of this.[4] However, the preintervention group consisted of more inpatient referrals also and had more patients who went directly to hospice once the TPC was inserted after the initial referral order. The intervention I and II groups consisted of more patients in which IP did a thoracentesis first. There were 13 patients that did not need TPCs placed in the intervention I group and 12 in the intervention II group due to patient mortality and resolution of pleural effusion without recurrence.

Hospital admissions were not different between the groups controlling for race, gender and cancer type were evaluated. The hospital admissions were not different between intervention I and intervention II. Therefore, the addition of follow-up phone calls did not show trends towards further improvement.

We noted that although TPCs should be considered early in the management of patients with MPE it is not always possible.[6] There were other delays in TPC placement in which we could not control. There were seven in the preintervention group, three in the intervention I group, and two in the intervention II group in which TPC was delayed due to negative cytology requiring further work-up and procedures. There were also 10 in the preintervention group, 12 in intervention I group and 7 in the intervention II group that refused the TPC for several visits prior to placement.

Our QI project consisted of administering surveys to stakeholders to determine interventions to decrease hospital admission rate in patients with MPE. The surveys pointed towards the gaps in knowledge and factors leading to delay in MPE management and geared us towards the interventions needed for decreasing hospital admissions. We found that stakeholders observed an improvement related to the interventions and reduction of unnecessary hospital admissions due to MPE. There was another QI study done in which the researchers evaluated the handover process between surgery and intensive care unit and implemented a standard handover process to decrease medical errors that improved provider satisfaction as well.[21]

In the surveys, the stakeholders noted that there were often delays in scheduling new referrals, which resulted in higher initial hospitalisation rate for management. However, most referrals were initiated when patients were significantly symptomatic with large pleural effusions. Therefore, these patients in particular are already close to needing intervention prior to even being referred. Early diagnosis and management of MPE can help decrease hospital admissions related to it, earlier referral is important to this process.[22]

The strengths of this project are the study design per the DMAIC model and reporting per the SQUIRE guidelines.[13 14] Recurrent hospital admissions from MPE contribute to a huge mental and financial burden on cancer patients at the end of life. This also raised satisfactions among the referral physicians and allied care providers. This project involved a multidisciplinary effort and engagement from our oncology attending physicians, nurses and case managers as well as the IP attending physicians, APPs, clinic nurses and respiratory therapists.

Limitations

Our study had some key limitations. We did not have control over the referring teams' referral processes, late clinical presentation of the patient and referral to a different team prior to engagement of the IP team. Patient preference on catheter insertion timing and whether they can get a catheter at all due to social issues such as insurance issues and caregiver help can influence timing of catheter insertion.

Another limitation is lack of patient involvement in this process; we did not survey them before and after the intervention so we were unable to collect any QOL changes. Also, this was a local QI project and not a randomised multi centre-controlled trial which limits our generalizability to other centres. The QI study overall had a small sample size in patient chart review as well as survey responses which can introduce bias in the results. It did not capture all of the providers that are involved with these patients due to the low response rate.

Sustainability

Triaging each referral for timely follow-up does require efficient teamwork and additional providers and scheduling staff time, which may be difficult to sustain long term without an allocation of resources. Measures are being put into place to ensure that all MPE referrals are still sent to APPs to triage for urgency. The post-thoracentesis phone call required nursing staff to make extra phone calls, which are difficult to sustain due to time restrains as well. Since there is little difference in hospital admissions between intervention I and intervention II, the triaging may be more feasible and relevant to sustain than the phone call.

Replication of this process could be difficult to maintain due to time constraints as it involves additional effort and time from the APPs and nursing staff which has been difficult to sustain. A nurse navigator may help sustain such a programme long term by reviewing referrals and follow-up on patients as a standard post procedure protocol.

CONCLUSIONS/INTERPRETATION

Our interventions showed trends toward fewer hospital readmissions if referrals were triaged by APPs and patients were followed closely post thoracentesis with a telephone follow-up. Even though the results did not reach statistical significance, its implementation could potentially reduce hospital readmission and healthcare cost.

Implications for future research

Larger size population-based studies and multicentre randomised controlled trials are needed to demonstrate the effectiveness of these interventions and to rule out confounding factors such as socioeconomic issues, patient preferences and source of referrals. The benefits and validation of such interventions would need to be customised to available local resources and staffing to enact policy change that is sustainable long term. Prospective research trials could validate these benefits and generalisability of these interventions.

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Contributors RRC was the guarantor. She designed the project, sent for IRB approval, submitted surveys, implemented the interventions, collected data on the intervention groups, wrote the first draft of the manuscript, helped rewrite many drafts of the manuscript and submitted it. EJ helped significantly with the second draft of the manuscript, rewriting large portions and helped edit the final draft. NP helped significantly with editing the final drafts before the submission. JM, MP and JPeng performed all of the statistics and helped write the portions of the manuscript involving the statistics. SV-W helped collect all the data for the preintervention group and she gave suggestions on the final drafts. CM helped call most of the patients for intervention II and made several edits to the final drafts. CG, CP and AR helped edit the final drafts and gave advice for the design of the project and its interventions. JPannu was the principal investigator and helped with every step of the project; she helped edit my design for the project, edit my survey questions and spent a major amount of time editing each draft of the manuscript.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants. Study Number: 2021C0004. The Office of Responsible Research Practices at the Ohio State University Wexner Medical Center. Since it was quality improvement, it was not needed.

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