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ORIGINAL ARTICLE

Implementation of Clinical Pathway to Diagnose Diffuse Parenchymal Lung Disease

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ABSTRAK

Pesakit dengan penyakit 'diffuse parenchymal lung diseases' (DPLD) akan mengalami kegagalan pernafasan, kecacatan fizikal kekal, kualiti hidup yang rendah sehingga menjadi beban besar kepada masyarakat. Aliran klinikal (CP) merupakan satu pelan penjagaan yang diselaraskan berdasarkan amalan berasaskan bukti dan garis panduan yang melibatkan pengurusan pelbagai disiplin untuk golongan pesakit tertentu dalam tempoh masa tertentu. Dengan kerjasama dan kolaborasi di antara pelbagai disiplin perubatan (respiratori, reumatologi, radiologi dan kesihatan awam), kami telah membangunkan satu CP untuk mendiagnosis DPLD. Tujuan pembangunan CP ini adalah untuk menyeragamkan penjagaan penyakit, mengurangkan kelewatan diagnosis, menggalakkan permulaan terapi awal, dan memberikan penjagaan berkualiti kepada pesakit. CP yang dibangunkan adalah untuk tujuan rawatan pesakit luar dan melibatkan empat lawatan klinik. Kajian ini menunjukkan bahawa pelaksanaan CP telah mengurangkan masa diagnosis median secara signifikan, iaitu selama 29 hari berbanding dengan 122 hari tanpa menggunakan CP. Pelaksanaan CP telah meningkatkan kerjasama antara pelbagai disiplin, perancangan penjagaan, keselamatan perubatan serta meningkatkan kualiti penjagaan pesakit dalam pengurusan DPLD.

Kata kunci: *'Diffuse parenchymal lung diseases'; pembangunan aliran klinikal; tempoh diagnosis*

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ABSTRACT

Patients with diffuse parenchymal lung diseases (DPLDs), inexorably progress to respiratory failure, permanent physical disability, poor quality of life, and becoming a significant societal burden. A clinical pathway (CP) is a coordinated care plan according to evidence-based practice and guidelines that involve multidiscipline management for a specific group of patients during a period. With cooperation and collaboration between various disciplines (respiratory, rheumatology, radiology and public health), we developed a CP to diagnose DPLDs. The aim of developing this CP is to standardise the care of the disease, reduce diagnosis delay, encourage early initiation of therapy and provide quality care to patients. The developed CP focuses on outpatient settings and involves four clinic visits. Our study demonstrates that utilising CP significantly reduces the time required to diagnose DPLDs, with a median diagnosis time of 29 days, as compared to 122 days without using CP. The CP implementation has improved multidisciplinary teamwork and care planning, medical safety and increased patient quality of care in the management of DPLDs.

Keywords: Clinical pathway; diagnose duration; diffuse parenchymal lung disease

INTRODUCTION

Diffuse parenchymal lung diseases (DPLDs) encompass a variety of pulmonary disorders that share similar clinical, radiologic and lung function features. Due to their diverse etiologies and the complexities of their diagnosis, DPLDs can be challenging to recognise promptly. Symptoms such as dyspnea, cough, chest discomfort and fatigue are common across many respiratory conditions, complicating accurate diagnosis. The overlap of symptoms with other respiratory illnesses, such as asthma, COPD and infections, can lead physicians to misdiagnose DPLDs or opt for a watchful waiting approach, particularly since some conditions are self-limiting. This misdiagnosis can cause further lung damage, decrease quality of life, and increase healthcare costs (Cottin et al. 2018). Therefore, timely and accurate diagnosis of DPLDs is crucial.

In 1999, the Institute of Medicine released a report that examined the healthcare system's response to medical errors, analysing their causes and impacts. This report has since driven efforts to enhance service quality and improve patient safety. The increased emphasis on creating safe, effective, efficient, timely, equitable, and patient-centered care has underscored the need for evidence-based clinical decision-making and the reorganisation of care processes (Stelfox 2006). This focus has led to the development and implementation of a clinical pathway (CP), which aims to improve clinical efficiency and enhance patient safety and care quality. Initially introduced in 1985 at New England Medical Center by Zander, Etheredge, and Bower, CPs-also known as care pathways, critical pathways, integrated care pathways, case management plans or care maps have evolved from industrial processes to become crucial components in quality improvement. They focus on effectiveness, safety, equity, efficiency and timeliness throughout the continuum of care (De Bleser et al. 2006).

Clinical Pathway Definition

According to the European Pathway Association (EPA), a CP is a "complex intervention for mutual decision-making and organisation of care processes for a well-defined group

of patients during a well-defined period." Research has further refined this definition to describe a CP as a structured multidisciplinary care plan with several characteristics. It translates guidelines or evidence into local structures and outlines the steps in a course of treatment or cares through a plan, pathway, algorithm, guideline, protocol, or other 'inventory of actions' including time-frames or criteria-based progression. CP aims to standardise care for a specific clinical problem, procedure, or episode of healthcare within a defined population. (European Pathway Association 2018; Vanhaecht 2007; Vanhaecht et al. 2010)

CPs are structured care plans derived from clinical practice guidelines to standardise care within specific populations. They detail critical steps in assessment and patient care by integrating evidence-based guidelines and often involve multiple disciplines to ensure a coordinated care plan. CPs help to prevent diagnostic delays by coordinating activities from history taking and physical examination to investigations and consultations with a multidisciplinary team for diagnosis confirmation (Hwang et al. 2022). In Malaysia, numerous studies have examined the development and implementation of CPs in clinical settings (Ban et al. 2012; Ismail 2012; Mad Tahir et al. 2022). The development of CPs for DPLDs is designed to streamline the diagnostic process and emphasise quality and coordinated care. By integrating activities from initial assessment to a multidisciplinary team (MDT) meeting, CPs aim to reduce diagnostic delays and enhance overall patient care. This paper aimed to develop a CP to diagnose DPLDs and assess its effectiveness.

MATERIALS AND METHODS

The development of the CP involved five key steps (Ban et al. 2012; Ismail 2012; Mad Tahir et al. 2022)

Step 1: Team Formation

The expert team consisted of respiratory physicians, radiologists, public health specialists and health economists. Team members were selected based on their clinical expertise, experience, and knowledge of the latest clinical practice recommendations and evidence-based guidelines. Their extensive experiences in managing DPLD in hospitals provided valuable insights into best practices, particularly in scenarios where healthcare services or facilities may be lacking.

Step 2: Information Sharing and Team Discussion

A series of discussions were conducted, which each expert outlined their goals. The team agreed that the CP should focus on diagnosing DPLDs in an outpatient setting. Activities were listed from both the patient's and clinicians' perspectives. The primary objectives were to specify and outline crucial history-taking questions, investigations and procedures necessary for diagnosing DPLDs.

Step 3: CP Development

The CP was structured according to time, activities/interventions, and outcomes. The timeline and core activities for each clinic visit were arranged according to hospital workload, including clinician consultations, types of investigations and procedures scheduled for patients. The CP draft was distributed to all team members for review and feedback. The feedback was evaluated and discussed to ensure the CP reflected current and comprehensive clinical practices. The revised

draft was then presented for consensus before implementation. The development of the CP was guided by several international guidelines as listed in Table S1 (Alarcón-Segovia and Cardiel 1989; American Thoracic Society/ European Respiratory Society 2002; Aletaha et al. 2010; Crouser et al. 2020; Fernández Pérez et al. 2021; Fischer et al. 2015; Hunninghake et al. 1999; Raghu et al. 2011; Raghu et al. 2018; Raghu et al. 2020; Tanaka et al. 2020).

Step 4: CP Implementation

The developed CP was implemented in the Medical Respiratory Clinic from January 2023 to December 2023 at two centers: Hospital Canselor Tuanku Muhriz, Universiti Kebangsaan Malaysia (UKM), Malaysia and Institute of Respiratory Medicine, Malaysia. Both centers specialise in respiratory medicine and have expertises in managing DPLDs. The primary department responsible for CP implementation was the Medical Respiratory team. The CP team educated and informed all healthcare providers not directly involved during the initial planning and development phase through the continuous medical education (CME) program. This training included briefings on the CP's objectives, procedures, and data recording and collection process. A timeline of activities was shared with all personnel to facilitate understanding and enhance proper documentation. Deviations from the CP were documented and evaluated to identify the underlying reasons. These deviations were reviewed to look into challenges in adhering to the CP, explore ways for better CP compliance, and ensure the integrity of the data used in the analysis.

Patient recruitment for CP implementation in the Medical Respiratory Clinic followed specific inclusion criteria. Eligible patients were Malaysian, above 18 years of age, and had provided consent to participate in the study. They were also suspected of having DPLDs based on their medical history, clinical presentation, or radiological findings. Patients with a history of pulmonary tuberculosis with significant fibrosis or those suffering from lung malignancies (primary or secondary) were excluded.

Based on these criteria, eligible patients were divided into two groups: the non-CP group and the CP group. The non-CP group comprised of patients diagnosed with DPLDs between 2018-2022, who were retrospectively recruited from medical records. The CP group, in contrast, consisted of patients who were recruited prospectively during the CP implementation period in the Medical Respiratory Clinic.

For the CP group, written informed consent was obtained from all patients. The study received ethical approval from the UKM Research Ethics Committee (Ref: UKM.FRF. SPI800-2/28 and the Medical Research and Ethics Committee of the Ministry of Health, Malaysia (Ref: (1)KKM/NIHSEC/23-00430). Participation was voluntary, and patients retained the right to withdraw from the study at any time for any reason. Reasons for withdrawal were documented in the case report form. All cases recruited in the CP group were reviewed and discussed in the MDT meetings. Only those with a confirmed DPLD diagnosis, as determined during the MDT discussions, were included in the analysis.

Step 5: CP Evaluation

The evaluation of the CP focused on both the care process and outcomes. The first variable measured was diagnosis duration, defined as the time taken to diagnose DPLDs, which was measured in days from the patient's first clinic visit until diagnosis confirmation in

the MDT meetings. This also includes the time interval from the initial clinic visit to the performance of the high-resolution computed tomography (HRCT) scan. Diagnosis duration was compared between the CP and non-CP groups to evaluate the effectiveness of CP.

The second variable measure was clinicians' satisfaction with the CP. This was measured using a 21-item questionnaire developed by Li et al. in 2021 which assessed three dimensions: organisational support, process identity and effect perception. The satisfaction level was measured using a Likert scale, a linguistic scale ranging from 1 to 5 (Sözen and Güven 2019), as shown in Table 1 below.

TABLE 1: Scoring range of Likert scale of the survey

Likert-Scale Description	Value	Interval
Strongly Dissatisfied	1	1.00-1.80
Dissatisfied	2	1.81-2.60
Not Sure	3	2.61-3.40
Satisfied	4	3.41-4.20
Strongly Satisfied	5	4.21-5.00

Statistical comparisons were conducted using SPSS version 21.0 (IBM Corp,Armonk, NY, USA) and Microsoft Excel 365 (Microsfoft Corporation, Washinton, USA) Continuous variables were analysed using the median and interquartile range (IQR), while categorical variables were assessed using frequency and percentage. The Mann-Whitney U test was employed to compare diagnosis durations between the CP and non-CP groups, with a p-value of <0.05 considered statistically significant.

RESULTS

CP Development

The CP is a detailed diagnosis plan involving four clinic visits, based on recommendations from the expert team to determine the essential clinical information and investigations required for diagnosing DPLDs in an outpatient setting, as outlined in Figure S1. The recommended time intervals between each clinic visit are illustrated in Figure 1. The first and second clinic visits focused on obtaining the patient's medical history and conducting a physical examination. Additional clinical information and investigations were reviewed during these visits as detailed in Table S1. Symptomatic treatment was initiated to alleviate the patient's symptoms. The case was then discussed in an MDT meeting to review clinical and radiological findings. The patient's diagnosis and management plan were established during the MDT meeting, and the consensus was documented in the patient's medical record. Based on the MDT meeting consensus, the care plan was discussed with the patient during the subsequent clinic visit. Further investigations may be considered for cases where a provisional diagnosis was not reached after the MDT meeting. The fourth clinic visit was scheduled 6-8 weeks later to review the patient's condition and the results of any further investigations. The estimated time to diagnose DPLDs using the CP ranges between 2 to 18 weeks.

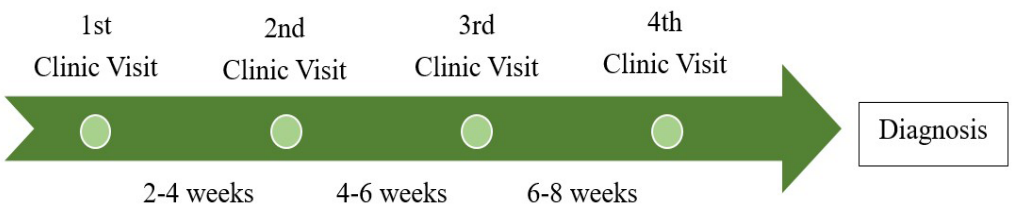

FIGURE 1: This figure illustrates the intervals between the four consecutive clinic visits for patients to diagnose DPLDs, with an indication of time (weeks) in between each visit. It is estimated the time taken to diagnose DPLDs ranges between 2 to 18 weeks

CP Implementation and Evaluation

During the CP implementation period, 103 patients were recruited, and the data collected were analysed by the researchers involved in the CP. For the historical non-CP control group, 261 medical case notes of patients diagnosed between January 2018 to December 2022 were reviewed. The evaluation focused mainly on diagnosis duration and clinicians' satisfaction.

- Diagnosis duration

The basic demographic distributions between the CP and non-CP groups were similar, with no significant differences observed ($p>0.05$), as shown in Table 2, except for smoking status. We found that the CP significantly reduced the time to diagnose DPLDs, with a median of 29 days compared to 122 days in the non-CP group, as shown in Table 3. The median time

TABLE 2: Baseline characteristics

Variables	CP group (n= 103)	Non-CP group (n= 261)	P-value
Age	66 (16)	67 (15)	0.385
Gender			
Male	52 (50.50%)	121 (46.40%)	0.478
Female	51 (49.50%)	140 (53.60%)	
Weight (kg)	66 (21)	61 (20)	0.304
Height (cm)	160 (14)	158 (14)	0.228
Smoking status			
Smokers	42 (40.80%)	116 (44.40%)	0.525
Non smoker	61 (59.20%)	145 (55.60%)	
Comorbidity			
Hypertension	56 (54.40%)	157 (60.20%)	0.313
DM	25 (24.30%)	85 (32.60%)	0.121
Dyslipidemia	41 (39.80%)	108 (41.40%)	0.783
Rheumato	20 (19.80%)	65 (24.90%)	0.304
Family History			
DPLD	3 (2.90%)	7 (2.70%)	1.000
CTD	3 (2.90%)	8 (3.10%)	1.000
Exposure	45 (44.60%)	103 (39.80%)	0.407

CP: clinical pathway; DM: diabetes mellitus; DPLD: diffuse parenchymal lung disease; CTD: connective tissue disease

TABLE 3 : Duration comparison between CP and Non-CP group

Variables	CP group (n= 103)	Non-CP group (n= 261)	P-value
Duration (days) - From 1st clinic visit to MDT meeting	29 (29)	122 (211)	<0.001
CT scan appointment (days) - From 1st clinic visit to HRCT scan	18 (10.5)	50 (93.5)	<0.001
CT scans 1 >1	 103 (100%) 0	 158 (60.5%) 103 (39.5%)	 <0.001 <0.001
Bronchoscopy	0	33 (12.6%)	<0.001

CP: clinical pathway; MDT: multidisciplinary team; CT: computed tomography; HRCT: high-resolution computed tomography

from the first visit to the HRCT appointment was also shorter in the CP group, at 18 days versus 50 days in the non-CP group. Additionally, some patients required multiple computed tomography (CT) scans and bronchoscopies before receiving their final diagnosis.

- Clinicians' satisfaction of the CP

The questionnaire was distributed among clinicians working in the medical team, with a total of 112 participants, including junior medical officers, senior medical officers, and specialists. The survey yielded scores ranging from a minimum of 51 to a maximum of 98. The mean satisfaction score was 3.84, indicating that most clinicians were satisfied with the developed CP. They reported that the CP positively impacted DPLD diagnosis practices, clinicians' workload, medical safety, and the doctor-patient relationship. The CP implementation also received strong support from the hospital's top management and supporting staff, contributing to its efficiency and rationality. However, clinicians expressed dissatisfaction that their income had not increased following the CP implementation.

DISCUSSION

DPLDs have evolved significantly over the past decades, with an increasing incidence and a complex, expanding classification of diseases. Patients with severe forms of DPLDs experience progressive loss of lung function, respiratory failure, and ultimately, death. Despite substantial advancements, there is still limited understanding of the pathogenic mechanisms and patient heterogeneity, particularly the variability in disease progression (Mikolasch et al. 2017). As a result, the diagnostic pathway for DPLDs is continually being improved and refined in response to advancements in techniques and precision medicine.

CP Activities Sequence and Timeline

The CP activities are planned and arranged in accordance with international clinical guidelines and local workload to ensure they are both achievable and efficient. The first and second clinic visits focus on gathering comprehensive information, including the patient's medical history, clinical evaluation and initial investigations such as serological tests, pulmonary function tests, and HRCT

scans. A second visit is recommended 2-4 weeks after the initial clinic visit to review the patient's condition and the results of the investigations. Integrating medical history, physical examination, and investigation findings are crucial for establishing an accurate diagnosis.

Role of HRCT Scans in Diagnosing DPLDs

Previous studies have highlighted that chest X-rays are less accurate and may miss some interstitial lung abnormalities. These studies reveal the superior predictive significance of interstitial lung abnormalities on CT scans compared to chest X-rays, particularly in relatives of patients with pulmonary fibrosis and in lung cancer screening programs (Hatabu et al. 2020; Hoffman et al. 2022; Hunninghake et al. 2020; Salisbury et al. 2020). With advances in imaging technology, HRCT scans are frequently recommended for patients suspected of DPLDs when an abnormal chest X-ray is detected by the referring physician. Current management emphasises the necessity of high-quality HRCT scans for the early diagnosis of DPLDs. According to the ATS/ERS statement of 2002, HRCT scan plays a crucial role in the diagnostic process for DPLDs, with poor-quality CT images leading to missed diagnoses and misinterpretations (American Thoracic Society/European Respiratory Society 2002).

Role of MDT Meetings in Diagnosing DPLDs

An MDT meeting is essential for confirming diagnoses and planning care. The CP recommends scheduling an MDT meeting within 10 weeks of the patient's first clinic visit. This 10-week timeframe allows for thorough preparation, regardless of case complexity. Previously, some patients had incomplete clinical data available at MDT meetings such as outsourced laboratory blood tests or imaging results, which hindered accurate diagnosis. Complex cases often experienced delays as pertinent results (e.g. ECHO reports, blood tests) and medical histories were sought during meetings. The CP ensures that all relevant information is summarised and prepared before the MDT meetings. The ATS/ERS statement (2013) emphasises the importance of integrating clinical data with radiological results for multidisciplinary diagnosis, including factors such as presentation, exposures, smoking status, comorbidities, lung function and laboratory results (Cottin et al. 2022; Glenn et al. 2022; Namas et al. 2023; Sanduzzi Zamparelli et al. 2023; Teoh et al. 2022; Tirelli et al. 2020; Travis et al. 2013; Walsh 2017).

The involvement of a respiratory physician and thoracic radiologist in the MDT meetings is recommended. Other specialists, such as rheumatologists, cardiothoracic surgeons, respiratory therapists, and palliative care experts, can also contribute. Previous studies indicated that at a minimum, a multidisciplinary review should include a clinician, a radiologist, and a pathologist. More comprehensive models, incorporating additional roles such as rheumatologists, thoracic surgeons, or ILD nurses, have been proposed. The composition of the MDT meetings significantly affects the discussion structure. MDT meetings focused on diagnosis versus those developing a therapeutic strategy may require different team members. For diagnostic purposes, the involvement of surgeons or specialised nurses may not be crucial (Cottin et al. 2022; Glenn et al. 2022; Namas et al. 2023; Sanduzzi Zamparelli et al. 2023; Teoh et al. 2022; Travis et al. 2013; Tirelli et al. 2020; Walsh 2017).

The role of rheumatologists in MDT

meetings warrants further discussion. A recent study found that seven international expert interdisciplinary panels established new diagnoses of CTD-ILD in about 10% of patients. The value of rheumatology input lies in the physical examination of patients for autoimmune conditions. However, the benefit of having a rheumatologist at MDT meetings without patient consultation remains unclear. DPLDs experts are adept at integrating lung function, imaging, and histology data. Ideally, evaluations of patients with suspected autoimmune characteristics by both an DPLDs experts and a rheumatologist in a parallel clinic would be optimal, though this may not always be feasible. Thus, MDT meetings may effectively consist of physicians, radiologists, and, when relevant, pathologists based on combined data.(Cottin et al. 2022; Namas et al. 2023 Glenn et al. 2022; Sanduzzi Zamparelli et al. 2023; Teoh et al. 2022; Travis et al. 2013; Tirelli et al. 2020; Walsh 2017).

CP Evaluation

- Diagnosis duration

Our study demonstrates that utilising CPs significantly reduces the time required to diagnose DPLDs, with a median diagnosis time of 29 days. This finding contrasts with longer diagnostic durations observed in studies that did not use CPs. Lancaster et al. (2022) reported a median of 7 months (approximately 210 days) from the first visit to final diagnosis. In comparison, the median diagnosis time in the non-CP group of our study was approximately 4 months (122 days). Cosgrove et al. (2018) found a median of 3 months from symptom onset to diagnosis, while Hoyer et al. (2019) noted a delay of about 1.2 months before patients visited a physician after initial symptoms. A recent study by Grant-Orser et al. (2024) indicated a median of 10.5 months to seek treatment after symptom onset.

Regarding the timeframe from symptom onset to final diagnosis, Cosgrove et al. (2018) reported a median of 7 months, which is significantly shorter compared to the study by Sköld et al. (2019), which recorded a median of 15.2 months. Recent studies performed by Snyder et al. (2020) and Grant-Orser et al. (2024) reported delays of 13.6 months and 12 months, respectively. Comparatively, studies conducted by Hoyer et al. (2019) and by Snyder et al. (2020) observed diagnostic delays of 25.2 months and 24 months, respectively.

The present study also reveals that the median time from the initial clinic visit to the HRCT appointment was 18 days in the CP group, compared to 50 days in the non-CP group. Studies done by Snyder et al. (2020) and Hoyer et al. (2019) reported similar durations of 3.5 and 3.6 months, respectively, from HRCT scan to final diagnosis. The study by Snyder et al. (2020) also found that 8.7% of patients were diagnosed between 1-2 years after imaging, 3.6% between 2-3 years, and 9.8% took more than 3 years.

- Clinicians' satisfaction of the CP

Clinician satisfaction with CP is essential, as it directly impacts job performance and reflects perceptions of organisational support, teamwork and the overall effects of CP implementation. Our study indicates that clinicians were generally satisfied with the developed CP. This finding aligns with a study conducted in Malaysia, which reported improved satisfaction due to better multidisciplinary communication, teamwork, care planning and efficient resource utilisation (Ismail 2012). Similarly, Yeh et al. (2014) found that CPs positively impacted medical facilities by enhancing doctor-patient relationships, increasing patient satisfaction, streamlining

case history recording, improving nursing quality, boosting procedure efficiency and aiding new recruits in learning work procedures.

Research done by Naqib et al. (2018) highlighted that CPs are effective tools for educating staff, increasing knowledge and enhancing patient satisfaction. Similar study by Askari et al. (2020) demonstrated that CP implementation significantly improved protocol monitoring and work efficiency among physicians, compared to supporting personnel such as nurses and paramedics. A pilot study by Noehammer et al. (2022) revealed that CP introduction was generally accepted by staff, who appreciated improvements in communication, collaboration, and patient safety, there was an increase in documentation due to enhanced transparency, clarity, and workflow alignment.

However, Panella et al. (2003) reported mixed results from staff regarding CP implementation. Some physicians expressed dissatisfaction with CPs for stroke and chronic renal failure, arguing that the pathways were too simplistic to address the heterogeneity of patients' conditions. Despite this, doctors generally observed significant improvements in care quality and cost reduction.

Importance of CP Development

The developed CP serves as a comprehensive guide for diagnosing DPLDs, which are often underdiagnosed. Given that not all clinicians are familiar with DPLDs, this can contribute to diagnostic delays. The CP is designed to expedite the diagnostic process by guiding clinicians through appropriate diagnostic and management options. Depending on the underlying diagnosis, managing DPLDs can be complex, with various potential approaches including further workups, watchful waiting, immunosuppressants or antifibrotics (Bendstrup et al. 2023; Nambiar et al. 2021; Wijsenbeek et al. 2022a; Wijsenbeek et al. 2022b).

Treatment strategies for DPLDs vary based on the type of disease and may include routine follow-ups or active immunosuppression, especially in patients with progressive DPLDs. Monitoring disease progression typically involves criteria such as absolute or relative declines in forced vital capacity (FVC) and diffusing capacity of the lungs for carbon monoxide (DLCO), a reduction in 6-minute walk distance of more than 50 meters, or worsening dyspnea and quality of life scores (Bendstrup et al. 2023; Nambiar et al. 2021; Wijsenbeek et al. 2022a; Wijsenbeek et al. 2022b).

In Malaysia, access to treatment is particularly challenging, especially for antifibrotic medications. Since November 2019, only nintedanib has been included in the Ministry of Health (MOH) drug formulary, while other antifibrotic medications require higher authority approval on a case-by-case basis (Balan et al. 2022; Malaysia Ministry of Health 2020). By promoting early diagnosis and initiation of therapy, this CP aims to improve patient outcomes. Further research is needed to evaluate the economic impact of DPLDs and to strengthen the evidence on the financial implications of this disease.

Success Factors in DPLDs CP Development and Implementation

Developing a CP is a complex process that demands commitment and collaboration from team members across various disciplines and backgrounds. A key factor contributing to the success of this CP was the involvement of a dedicated and experienced team. The expert team comprised highly trained

respiratory physicians, thoracic radiologists, rheumatologists, public health specialists, and health economists, all of whom are well-versed in the management of DPLDs and CP development. Leveraging their extensive experience, they successfully created an effective CP that encompasses disease investigation activities, including patient medical history, physical examination, procedures, investigations, and MDT meetings (Alcimed 2021; Choo 2001; De Allegri et al. 2011; Noehammer et al. 2022).

Their expertise helped to raise awareness and reduce resistance to the development of a CP for DPLDs. The multidisciplinary team's dedication and accountability were crucial, particularly since CP development was an additional responsibility for healthcare professionals (Alcimed 2021; Choo 2001; De Allegri et al. 2011; Khalifa and Alswailem 2015).

A study by Noehammer et al. (2022) also highlight the importance of a committed multidisciplinary team in achieving high success rates. The active involvement of enthusiastic team members facilitated effective utilisation of the CP through a series of discussions. Previous studies have shown varying levels of involvement in CP development, with nurses participating in 96% of cases, doctors contributing to 85%, allied health professionals accounting for approximately 70%, management involved in 48%, and patients contributing 26% (Vanhaecht et al. 2006).

Effective communication was pivotal in the successful development and implementation of the DPLDs CP. This was further enhanced by a series of meetings and collaboration within Klang Valley, which facilitated clear and efficient communication. Strong relationships within the expert team and clear verbal communication helped minimise duplication of efforts and establish a clear division of roles, responsibilities and accountabilities. Studies indicate that effective communication is essential for good teamwork and joint decision-making, bridging knowledge gaps due to diverse fields and enabling productive collaboration (Busari et al. 2017; Chichirez & Purcărea 2018; Kreps 2016; Šimec et al. 2021).

The success of the CP development and implementation can also be attributed to the support from hospital leaders and top management. The Heads of the Department of Medicine, Radiology, and Public Health at UKM demonstrated a strong commitment to quality improvement in DPLD management. They supported the CP development by providing necessary resources, including personnel and funding. Since its initiation in 2009, the CP has proven effective in enhancing patient safety, improving care quality, and organising healthcare services more efficiently (Aniza et al. 2016; Ban et al. 2012; Ismail 2012). The support from top management was crucial, aligning with the findings on the importance of leadership support for successful development and implementation (Noehammer et al. 2022).

Study Limitation

- CP development

Patient engagement was insufficient during the design phase of this CP. Effective patient involvement in CP development is crucial for fostering strong communication between patients and healthcare professionals. It helps to clarify patient roles and facilitate solutions and care priorities throughout CP implementation, potentially increasing compliance rates and enhancing quality through patient experience sharing sessions. However, barriers to patient participation in CP design have been identified, including insufficient knowledge about the disease, treatment, and the CP itself, poor interaction with physicians and a

lack of feedback mechanisms. Strategies to enhance patient engagement during CP design and implementation should be promoted to improve CP organisation (Al-Tannir et al. 2017; Wind et al. 2021).

Another area requiring further exploration is the utilisation of the CP in inpatient settings. Further work is needed to establish patient admission criteria, discharge criteria and discharge plans. CPs provide a structured framework that supports consistent decision-making and ensures timely delivery of appropriate treatment, similar to approaches used for conditions like sepsis, ARDS, and shock. However, a significant challenge in adapting the CP for inpatient settings is the variability in patient conditions during hospitalisation. Different subtypes of DPLDs patients may experience varying health issues, and sudden clinical deterioration or complications may necessitate deviations from the CP. Therefore, additional research is needed to determine which CPs are beneficial for inpatient settings and how they can be implemented to optimise patient care (Sevransky et al. 2021).

- CP implementation and evaluation

During the CP implementation, we encountered several deviations from CP. The reasons for deviation are attributed to the aspects of medical workers and the medical process. In the initial phase, there were challenges in effectively disseminating information on the CP. Additionally, several medical officers were rotated into the department during this period. To address this, the CP team ensured the newly rotated medical officers were briefed on CP implementation during their orientation. Some cases, initially suspected of being DPLD, were later confirmed as non-DPLD during the MDT. These scenarios led to deviations from the CP and were excluded from the study. These patients will continue to be followed up in the clinic and managed according to their final diagnoses and care plans recommended during the MDT.

The present study also concentrated on measuring the time from the initial clinic visit to diagnosis confirmation. Due to limitations in data retrieval and the lack of clear documentation in medical records, we did not measure the duration before the first clinic visit. This limitation restricts our ability to explore additional patient-related factors and compare our findings with previous studies.

Additionally, while we evaluated clinicians' satisfaction with the CP, a more comprehensive assessment should include feedback from all individuals involved in the CP implementation phase, such as nurses, pharmacists, radiographers and patients. Gathering feedback from all these stakeholders will help to refine the pathway for diagnosing and managing DPLDs, leading to improved overall outcomes.

CONCLUSION

This paper details the development process of a CP for diagnosing DPLDs, which has been pilot-tested within an institutional hospital setting. The consensus reached by the expert team guides clinicians in Malaysia in identifying and diagnosing potential DPLDs patients. While the CP offers clear advantages, its application and implementation also present certain challenges. Hospitals must carefully identify, coordinate and rigorously monitor the CP's implementation to achieve optimal results. Further research is necessary to evaluate the CP from additional perspectives, including its impact on patient care quality and clinical training for clinicians.

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DPLD Clinical Pathway (CP) Visit 1

Name				(√)	Years
Age / Ethnicity	/ M C I Others	Premorbid (# years)	RA		
MRN		Height : M	Scleroderma		
IC		Weight : kg	SLE		
Contact number		BMI : kg/M²	MCTD		
Rheumatology Follow up: Yes / No			Others: _____		
Smoking history	Ex- smoker ( )	Pack Years ( )			
	Non-smoker ( )				
	Passive smoker ( )				
	Current smoker ( )	Pack Years ( )			
Family history of DPLD	yes/no				
Family history of CTD	yes/no (If Yes, state:)				
Visit 1 (Day 0)	Date:		(√)	Duration(mth)	
Comprehensive	Symptoms	Cough			
history	(Tick if present)	Dyspnoea			
		Reduce ET			
		Chest pain			
		Wheezing			
		Weight loss			
		Reduce appetite			
		Fever			
		Joint pain			
		Others			
	Exposure	Biomass			
	(Tick if present)	Silica			
		Bird dropping			
		Asbestos			
		Flour			
		Others			
Clinical parameters	Sp02	≥95% (yes/no) Value:			
	Fingers	Clubbing	yes/no		
	Lungs	Coarse crepitations	yes/no		
		Fine (Velcro) crepts	yes/no		
	Cardiovascular	Loud P2	yes/no		
		Signs of HF	yes/no		
Laboratory testing	FBC ( )	RF ( )			
(To be ordered)	RP ( )	Others (specify)			
	LFT ( )				
	ANA ( )				
Imaging	Chest radiograph	Done / Not done	If HRCT done,		
(To order if not done)	HRCT	Done / Not done	results:		
Pulmonary testing	Spirometry	Done/Not done			
(To order if not done)	DLCO	Done/Not done			
	6MWT	Done/Not done			
	ECHO (if indicated)	Done/Not done			

Date of Appointment for Visit 2 :
(within 2-4 weeks)

FIGURE S1a: Clinical Pathway Developed to diagnose DPLDs (Visit 1)

DPLD Clinical Pathway (CP) Visit 2

Name		
MRN		
IC		
Visit 2	Date:	
(2-4 weeks)	yes/no	# Of weeks from 1st visit:
Review of autoimmune Screening	ANA RF	Positive / Negative Positive / Negative
Review Pulmonary Function Tests	Spirometry	
	DLCO	
	6MWT	
Review of HRCT Date done: Formal reporting:	UIP probably UIP	
	Indeterminate UIP	
	NSIP OP	
	HP	
	Others / Excluded from CP	Specify:
Preliminary diagnosis (Pre – MDT)		
Management	Further autoimmune screening (yes/no) ENA/C-anca, P-anca/Myositis panel	Other management (specify) SABA ( ) Mucolytics ( ) Vaccination ( ) Specify _____ Others:
MDT Meeting	Date:	

Date of Appointment for Visit 3 :
(within 4-6 weeks)

FIGURE S1b: Clinical Pathway Developed to diagnose DPLDs (Visit 2)

DPLD Clinical Pathway (CP) Visit 3

Name MRN			
IC			
Visit 3	Date:		
4-6 weeks	yes /no		# Of weeks from 1st visit:
MDT done	yes/no		
	If not done, state reason:		
Diagnosis post MDT			
	(Same dx / change of dx)		
Need for bronchoscopy	Yes/no		
	Yes	BAL	Cell count:
			TB work up: Pos / Neg
		TBLB	Done / Not done
			Results:
		TBLC	Done / Not done
			Results:
Surgical lung biopsy	Yes /no	Results	
Review of autoimmune screening test			
Further management	Treatment initiated (Yes/No)		
	If yes, specify with dosage		
	Prednisolone ( ) Dose:		Pirfenidone ( ) Dose:
	Azathiprine ( ) Dose:		Nintedanib ( ) Dose:
	MMF ( ) Dose:		MTX / HCQ ( ) Dose:
	Cyclophosphamide ( ) Dose:		

Date of Appointment for Visit 4 :
(within 6-8 weeks)

FIGURE S1c: Clinical Pathway Developed to diagnose DPLDs (Visit 3)

DPLD Clinical Pathway (CP) Visit 4

Name		
MRN		
IC Visit 4 |	Date:	
6-8 weeks	yes/no	#Of weeks from the 1st visit:
Confirmed diagnosis	yes/no	
State diagnosis		
Reason why diagnosis not confirmed and state reason	Cost related Patient related Logistics	
Need further workup (Yes / No) (Please indicate if needed) 1) Pulmonary Function test ( ) 2) Follow up HRCT ( ) 3) Clinical assessment ( )		
Watchful waiting?	Yes/No	
Treatment initiation	Yes/No	
Treatment options	**Drugs (√ / X)**	**Dosage**
	Prednisolone Azathioprine MMF	
	Cyclophosphamide	
	Pirfenidone Nintedanib MTX / HCQ	
	Others:	

FIGURE S1d: Clinical Pathway Developed to diagnose DPLDs (Visit 4)

TABLE S1: List of International Guideline referred for CP development

International guidelines for CP development

· An Official American Thoracic Society (ATS), the European Respiratory Society (ERS), the Japanese Respiratory Society (JRS), and the Latin American Thoracic Association (ALAT) Statement: Idiopathic Pulmonary Fibrosis: Evidence-based Guidelines for Diagnosis and Management.
· Diagnosis of Idiopathic Pulmonary Fibrosis. An Official ATS/ERS/JRS/ALAT Clinical Practice Guideline.
· ATS/ERS Multidisciplinary Consensus Classification of the Idiopathic Interstitial Penumonias.
· An Official ERS/ATS Research Statement: Interstitial Pneumonia with Autoimmune Features.
· ATS/ERS/World Association of Sarcoidosis and Other Granulomatous Disorders (WASOG) statement on sarcoidosis. American Thoracic Society/European Respiratory Society/World Association of Sarcoidosis and other Granulomatous Disorders. Sarcoidosis, vasculitis, and diffuse lung diseases : official journal of WASOG.
· Diagnosis and Detection of Sarcoidosis. An Official ATS Clinical Practice Guideline.
· American College of Rheumatology (ACR)/the European League Against Rheumatism (EULAR) 2010 Rheumatoid Arthritis Classification Criteria.
· Diagnosis and Evaluation of Hypersensitivity Pneumonitis: CHEST Guideline and Expert Panel Report.
· Diagnosis of Hypersensitivity Pneumonitis in Adults: An Official ATS/JRS/ALAT Clinical Practice Guideline.
· 2019 Diagnostic Criteria for Mixed Connective Tissue Disease (MCTD): From the Japan Research Committee of the Ministry of Health, Labor, and Welfare for Systemic Autoimmune Diseases.
· Diagnostic Criteria for MCTD by the Alarcón-Segovia Diagnostic Criteria.