AVALIAÇÃO DE CONGESTÃO POR ECOGRAFIA PULMONAR EM PACIENTES AMBULATORIAIS COM INSUFICIÊNCIA CARDÍACA: AUXILIO NA TOMADA DE DECISÕES E SEGUIMENTO CLÍNICO

Dissertação de Mestrado

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Programa de Pós-Graduação em Ciências da Saúde:

Cardiologia e Ciências Cardiovasculares

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LISTA DE ABREVIATURAS

BRA	Bloqueador do receptor da Angiotensina
CDI	Cardiodesfibrilador implantável
DPN	Dispneia Paroxística Noturna
DPOC	Doença pulmonar obstrutiva crônica
ECC	Escore Clínico de Congestão
ECR	Ensaio Clínico Randomizado
FE	Fração de Ejeção
IC	Insuficiência Cardíaca
IECA	Inibidor da Enzima Conversora da Angiotensina
HR	Hazard ratio
MMII	Membros inferiores
NYHA	New York Heart Association
PVC	Pressão Venosa Central
TC	Tomografia Computadorizada
US	Ultrassonografia
RX	Radiografia
VCI	Veia Cava Inferior
VE	Ventrículo Esquerdo
VPN	Valor Preditivo Negativo
VPP	Valor Preditivo Positivo

RESUMO

A insuficiência cardíaca (IC) é síndrome clínica na qual o miocárdio falha em prover débito cardíaco de forma a atender as necessidades metabólicas tissulares. A congestão pulmonar, sinal mais comum da IC, é preditor de pior prognóstico, maior mortalidade e internação hospitalar. Nesse sentido, a congestão é o principal alvo terapêutico nos pacientes com IC a fim de evitar tais desfechos. Todavia, a avaliação clínica exclusiva é pouco sensível e específica, podendo não detectar adequadamente a congestão, principalmente em pacientes ambulatoriais, nos quais existem fatores adaptativos que mascaram o seu reconhecimento. Nos últimos anos, a ultrassonografia (US) pulmonar mostrou-se uma ferramenta útil na detecção de congestão nesses pacientes através da identificação das linhas B no parênquima pulmonar. No presente trabalho, avaliamos o uso da US pulmonar na identificação de congestão somando-se aos dados do exame clínico para auxiliar nas decisões de ajuste de diurético e sua associação com desfechos clínicos a médio prazo. Entre Abril a Novembro de 2019, foram incluídos 239 pacientes e no seguimento foram analisados um total de 204 pacientes. Foram incluídos pacientes com IC com fração de ejeção reduzida ou preservada, idade média de 62 (±13) anos, 66% do gênero masculino e 79% em classe funcional NYHA II ou III. A mediana do escore clínico de congestão foi de 3.98 ±2.5 pontos e do US pulmonar foram de 6 (1-20) linhas B. A maioria dos pacientes sem congestão não apresentaram linhas B ao US 46 (68%), porém 56 (41%) dos pacientes classificados como clinicamente congestão não apresentaram congestão ecografia. Por outro lado, 10 (15%) daqueles sem congestão ao ECC, apresentaram congestão moderada a grave no US pulmonar. A prescrição de diuréticos foi modificada em 75 (36,7%) dos casos após os dados da ecografia. Os pacientes nos quais a dose de diurético foi aumentada após o uso do US apresentaram maior risco de internação por IC e mortalidade com HR de 1.6 (IC 1.01-2.66, p = 0.04). Na avaliação pela US pulmonar, pacientes congestos apresentaram maior mortalidade que aqueles não congestos [26 (26%) vs. 4 (4%), p<0.0001)] com HR de 7.1 (IC 95% 2.4-20.2, p<0.001). Pacientes com congestão clínica e ecográfica apresentaram maior taxa de mortalidade [23 (77%)] do que pacientes somente congestos apenas pela escala ECC [2 (7%)], apenas pelo US pulmonar [3 (10%)], e em relação aos não congestos [2 (7%)] com HR de 7.6 (IC 95% 1.8-32.4, p = 0.006). Com base nestes dados, podemos afirmar

que a US pulmonar é uma ferramenta simples e que tem impacto na avaliação da congestão, tratamento diurético e no seguimento a médio prazo dos pacientes com IC em acompanhamento ambulatorial. Estudos randomizados robustos são necessários para demonstrar o impacto clínico de estratégias utilizando esta informação.

Palavras-chave: insuficiência cardíaca, congestão pulmonar, ultrassonografia pulmonar, diuréticos.

ABSTRACT

Heart failure (HF) is a clinical syndrome in which the myocardium fails to provide cardiac output in order to meet tissue metabolic needs. Pulmonary congestion, the most common sign of HF, is a predictor of worse prognosis, higher mortality and hospitalization. Therefore, congestion is the main therapeutic target in patients with HF in order to avoid such outcomes. However, the clinical evaluation alone is not sensitive nor specific, and may fail to adequately detect congestion, especially in outpatients, in whom there are adaptive factors that mask its recognition. In recent years, pulmonary ultrasound (LUS) has proved to be a useful tool in detecting congestion in these patients by identifying B lines in the lung parenchyma. In the present study, we aimed to evaluate the use of the LUS to identify congestion in addition to clinical examination to assist in diuretic adjustment decisions and their association with medium-term clinical outcomes. From April to November 2019, 239 heart failure patients were included and a total of 204 patients were analyzed in the follow-up. HF patients with reduced or preserved ejection fraction, mean age of 62 (±13) years, 66% male and 79% in NYHA functional class II or III were included. The median of clinical congestion score (CCS) was 3.98 ±2.5 points and B-lines in LUS was 6 (1-20). Most patients without congestion had no B lines at US (46 (68%), but 56 (41%) of the patients classified as clinically congestion did not present ultrasound congestion. On the other hand, 10 (15%) of those without congestion on CCS had moderate to severe congestion on LUS. The prescription of diuretics was modified in 75 (36.7%) of the patients after the ultrasound data. Patients whose diuretic dose was increased after LUS had a higher risk of hospitalization for HF and mortality with a *hazard ratio* of 1.6 (CI 1.01 – 2.66, p = 0.04). On LUS assessment, congested patients had higher mortality than non-congested [26 (26%) vs. 4 (4%), p<0.0001)] *hazard ratio* of 7.1 (CI 95% 2.4-20.2, p<0.001). Patients with clinical and ultrasound congestion had a higher mortality [23 (77%)] than patients with only congestion by the CCS alone [2 (7%)], by LUS alone [3 (10%), and in relation to non-congested [2 (7%)], with *hazard ratio* of 7.6 (CI 95% 1.8-32.4, p = 0.006). Based on these data, we can say that LUS is a simple tool that has an impact on the assessment of congestion, diuretic treatment and on the medium-term follow-up of outpatients with HF. Further randomized trials are needed to demonstrate the clinical impact of strategies using this information.

Keywords: heart failure, pulmonary congestion, lung ultrasound, diuretics

REVISÃO DE LITERATURA

Dispneia - experiência subjetiva de desconforto respiratório - é um sintoma chave para uma variedade de doenças crônicas e agudas, incluindo doença pulmonar obstrutiva (DPOC), asma, pneumonia ou insuficiência cardíaca (IC) (1). Sua subjetividade é uma das principais dificuldades enfrentadas pelo clínico cuja tarefa é determinar o diagnóstico e avaliar a gravidade da condição subjacente (2). Além disso, a dispneia tem o potencial de predizer resultados clínicos adversos (4-7), por isso, a elucidação diagnóstica nos pacientes com esse sintoma é de extrema relevância.

Os pulmões podem fornecer uma grande quantidade de informações diagnósticas, no entanto, a avaliação clínica continua sendo um desafio para diferenciar as causas de dispneia devido a sua baixa sensibilidade (8). A ultrassonografia (US) pulmonar auxilia na elucidação das causas de dispneia aguda em poucos minutos a beira leito (9-10) e não somente é superior ao exame físico e a radiografia de tórax (RX), mas mesmo comparável à tomografia computadorizada (TC) para muitos diagnósticos: pneumonia, embolia e edema pulmonar, asma e DPOC podendo ser avaliadas com sensibilidade e especificidade variando de 90 a 100% (11).

INSUFICIÊNCIA CARDÍACA

A IC é uma síndrome clínica na qual o coração é incapaz de prover débito cardíaco de forma a atender às necessidades metabólicas tissulares. Pode ser causada por anormalidade cardíaca estrutural ou funcional e caracteriza-se por sinais e sintomas típicos como dispneia, edema de membros inferiores, pressão venosa jugular elevada e congestão pulmonar que resultam da redução do débito cardíaco e/ou da elevação das pressões de enchimento no repouso ou no esforço (12).

A congestão pulmonar, sinal mais comum da IC, é a principal causa de hospitalização nos EUA na população acima dos 65 anos (13) e suas características clínicas não são específicas para IC, podendo ocorrer em muitas outras condições como síndrome nefrótica, doença hepática, doença tireoidiana, insuficiência venosa ou como efeito adverso de medicamentos como bloqueadores do cálcio ou glitazonas (16).

Apesar dos avanços no tratamento da IC, essa patologia é um importante problema de saúde pública, afetando, no mundo, mais de 23 milhões de pessoas (15) e com altas taxas de morbidade e mortalidade (18). A sobrevida após cinco anos de diagnóstico pode ser de apenas 35%, com prevalência que aumenta conforme a faixa etária, chegando a 17,4% naqueles com idade maior ou igual a 85 anos (19). Sua incidência e prevalência aumentaram progressivamente nos últimos anos e estima-se que, em países desenvolvidos, 1-2% dos adultos apresentem IC.

No Brasil, informações obtidas do DATA-SUS demonstram que em 2016 ocorreram 28.777 mortes por IC, das quais 5.156 foram na região Sul (15). O registro BREATHE (Brazilian Registry of Acute Heart Failure) demostrou alta taxa de mortalidade intra-hospitalar relacionada à IC, sendo a principal causa de internação hospitalar. Além disso, quase 50% de todos os pacientes internados com esse diagnóstico são readmitidos dentro de 90 dias após a alta hospitalar sendo a má aderência a terapêutica a principal causa.

Fatores de risco para IC incluem cardiopatia isquêmica, miocardite, valvulopatias, taquicardiomiopatias, diabetes mellitus, cardiopatia congênita, apneia do sono, uso abusivo de álcool e obesidade. Uma porcentagem significativa (30-40%) é causada por fatores genéticos. Associado a isso, alguns medicamentos aumentam o risco de IC como antiinflamatórios não esteroidais e quimioterápicos. Sabe-se, também, que a há uma variabilidade mundial e regional de etiologia da IC, e a busca pela causa tem particular importância uma vez que apresentam diferentes prognósticos (17).

O prognóstico dos portadores de IC melhorou ao longo dos anos devido desenvolvimento de drogas e dispositivos que comprovadamente reduzem mortalidade como betabloqueadores, inibidores da enzima conversora da angiotensina, antagonistas da aldosterona, inibidores da neprisilina, inibidores de SGLT2, terapia de ressincronização miocárdica e cardiodesfibrilador implantável. Sabe-se, que apesar da maioria dos pacientes utilizarem cronicamente, não há ensaio clínico randomizado que tenha demonstrado aumento de sobrevida com o uso de diuréticos em pacientes com IC crônica ambulatorial (12).

CONGESTÃO PULMONAR

A terapia diurética, especialmente os diuréticos de alça, é a maneira usual de controlar a congestão em associação com a terapia médica otimizada (19). A diureticoterapia auxilia o controle da congestão pulmonar e sistêmica promovendo alívio sintomático (19). O uso desta classe de medicação é considerado primeira linha de tratamento específico para congestão independente da etiologia (20). São utilizados para manutenção da euvolemia com a menor dose possível, evitando o risco de desidratação que pode levar a hipotensão e disfunção renal. Pacientes que permanecem com sinais de congestão ao exame clínico sabidamente evoluem com pior prognóstico, maior mortalidade e maiores taxas de re-hospitalizações (20–22).

Em pacientes crônicos, a congestão pulmonar geralmente se desenvolve de forma gradual. A detecção de sinais clínicos de congestão pode estar atenuada ou ausente devido a processos adaptativos e pela grande capacidade do sistema linfático em lidar com a congestão – figura 1. Muitos pacientes podem ter pressões de enchimento elevadas no ventrículo esquerdo (Pd2) mesmo quando os sinais clínicos de congestão estão ausentes (31). Assim, os sinais clínicos de congestão podem ser pouco sensíveis e também pouco específicos (24). Desta forma, o exame físico muitas vezes falha em detectar adequadamente congestão nos pacientes ambulatoriais e a US pulmonar se torna uma ferramenta útil para a detecção de congestão e pode facilitar o manejo clínico desses pacientes e fornecer informações prognósticas (25).

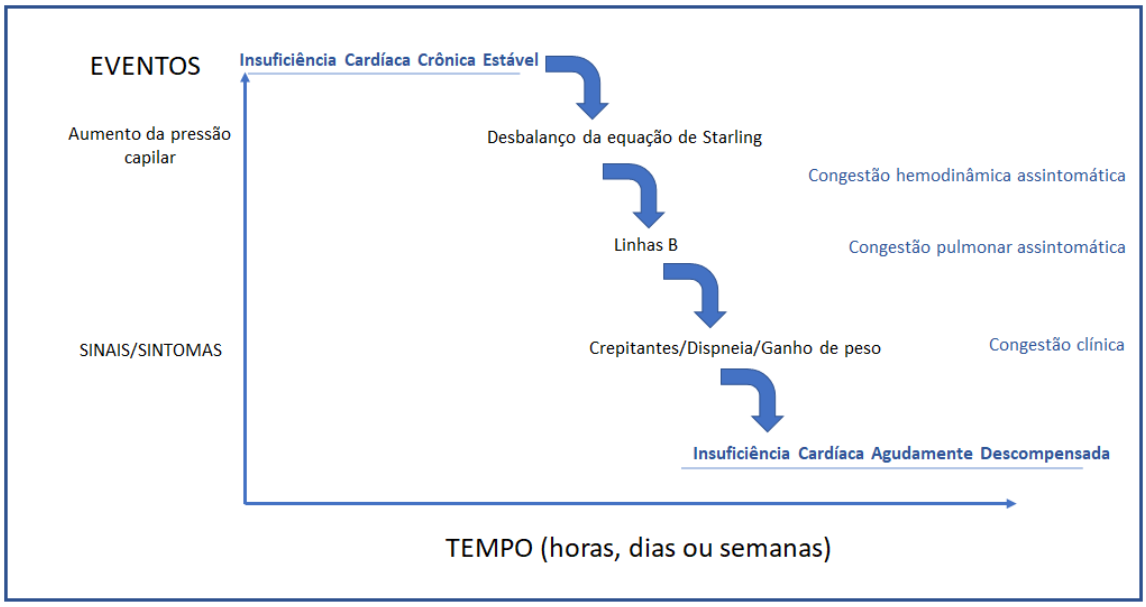

Figura 1. Adaptado de Picano, et al ACC Vol 1. No 11, 2018

No intuito de melhor caracterizar a hipervolemia em pacientes ambulatoriais com IC, escores de avaliação clínica foram desenvolvidos. No Escore Clínico de Congestão (*Clinical Congestion Score - CCS*) – tabela 1, os sinais de congestão ao exame clínico são pontuados e o resultado obtido pela soma desses pontos indica o grau de hipervolemia. O paciente é considerado congesto quando soma ≥3 pontos e tem correlação com pior sobrevida e maior morbidade (14).

Tabela 1. Escore Clínico de Congestão

Classe Funcional
NYHA I – 1 ponto
NYHA II – 2 pontos
NYHA III – 3 pontos
NYHA IV – 4 pontos
Ortopneia e Dispneia Paroxística Noturna (DPN)
Uso de 1 travesseiro em cama plana – 0 pontos
Mais de 1 travesseiro para dormir – 1 ponto
Pelo menos 1 episódio de DPN na última semana – 2 pontos

	Múltiplos episódios de DPN na última semana – 3 pontos
	Dormiu sentado pelo menos uma noite na última semana – 4 pontos
Edema	
	Sem edema – 0 pontos
	Edema 1+/4+ – 1 ponto
	Edema 2+/4+ – 2 pontos
	Edema 3+/4+ – 3 pontos
	Edema 4+/4+ – 4 pontos
Estertores pulmonares	
	Ausentes – 0 pontos
	< ¼ campos pulmonares (bases) – 1 ponto
	¼ a ½ dos campos pulmonares – 2 pontos
	> ½ dos campos pulmonares – 3 pontos
	Todos os campos pulmonares – 4 pontos
Presença de B3	
	Não – 0 pontos
	Sim – 1 ponto
Refluxo Hepatojugular	
	Não – 0 pontos
	Sim – 1 ponto
Estimativa da PVC (em cmH_2O acima do ângulo esternal)	
	PVC não mensurável – 0 pontos
	PVC entre 5-8 cmH_2O – 1 ponto
	PVC entre 8-12 cmH_2O – 2 pontos
	PVC entre 12-15 cmH_2O – 3 pontos
	PVC > 15 cmH_2O – 4 pontos

EXAMES COMPLEMENTARES PARA AVALIAÇÃO DE CONGESTÃO PULMONAR

Métodos tradicionais como RX de tórax são relativamente insensíveis à detecção de congestão pulmonar, uma vez que até 20% dos pacientes ambulatoriais tem esse exame normal mesmo quando já apresentam congestão pulmonar (26). Além disso, a anamnese e o exame físico apresentam uma baixa sensibilidade para a detecção de Pd2 elevada e congestão pulmonar e, apesar da alta especificidade, achados anormais frequentemente são ausentes (27).

Em 2008, no ESCAPE trial, Drazner e cols avaliaram a capacidade diagnóstica de achados da anamnese e do exame físico em detectar pacientes com congestão. Esta, avaliada de forma invasiva através da pressão de oclusão da artéria pulmonar > 22 mmHg, que é uma medida objetiva de congestão e hipervolemia. A tabela 2 descreve os achados.

Tabela 2. Performace de achados do exame físico para detecção de congestão

Achados	Sensibilidade	Especificidade	VPP	VPN
Crepitantes*	15	89	69	38
Terceira bulha	62	32	61	33
Ascite (moderada/severa)	21	92	81	40
Edema (≥2+)	41	66	67	40
Ortopneia**	86	25	66	51
Hepatomegalia***	15	93	78	39
Refluxo hepatojugular	83	27	65	49

Valores expressos em porcentagem. * ≥1/3 campos pulmonares. ** ≥2 travesseiros

*** Borda hepática palpável >4 dedos abaixo do rebordo costal direito. VPP, valor preditivo positivo; VNP, valor preditivo negativo.

US PULMONAR PARA AVALIAÇÃO DE CONGESTÃO

A US pulmonar tem sido uma ferramenta útil na avaliação de pacientes com IC aguda e crônica e permite detectar congestão pulmonar mais acuradamente que a ausculta pulmonar ou RX de tórax (11). Tal fato é obtido através da detecção das linhas B, definidas como linhas verticais, perpendiculares ao eco pleural e com origem nele, com aspecto em "cauda de cometa" e que representam os septos interlobulares – figura 2. Em até 30% dos pacientes sadios, uma ou duas linhas B podem ser encontradas por espaço intercostal, sem conotação patológica. Porém, quando em número elevado, representam o preenchimento de um septo interlobular ou intralobular sugerindo edema pulmonar ou intersticial. Outro aspecto relevante desta técnica é que aliada ao RX de tórax, muitas vezes é suficiente para o diagnóstico e a conduta das afecções pulmonares, reduzindo, o tempo da conduta terapêutica. Além disso, sua relativa rápida curva de aprendizado e grande concordância interobservador, incrementam sua reprodutibilidade e acurácia (10).

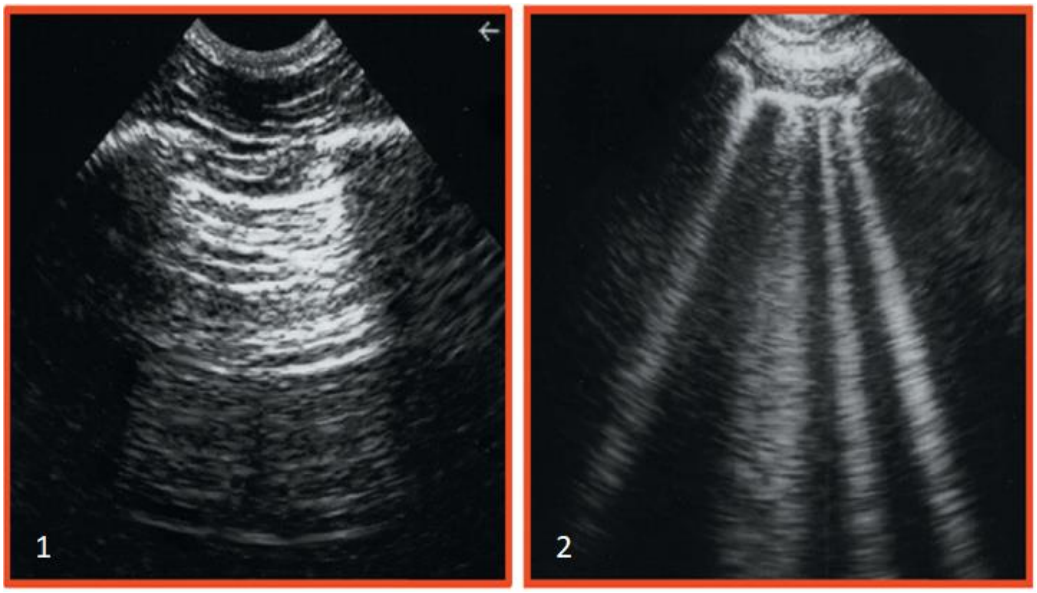

Figura 2. Imagens de US pulmonar. Adaptado de Picano e Cols (2018). 1) Parênquima pulmonar normal. Visualiza-se a linha pleural (linha A) que são artefatos horizontais pleuro-pulmonares e indicam ar abaixo da linha pleural. 2) Artefatos verticais com aspecto de "cauda de cometa" sugestivo de congestão pulmonar.

As imagens do US são realizadas por aparelho de ultrassom que possua transdutor convexo. Existem diversos protocolos para obtenção das imagens, no mais clássico, são avaliados vinte e oito sítios torácicos (dezesseis sítios no hemitórax direito e doze sítios no hemitórax esquerdo). O exame é realizado com o paciente em decúbito dorsal e de acordo com o número de linhas B em cada campo pulmonar se define o grau de congestão.

Para o diagnóstico diferencial das afecções pulmonares, avalia-se os padrões de linhas B associados a outros achados pulmonares. Na pneumonia e síndrome respiratória aguda grave, por exemplo, existe uma redução do deslizamento pulmonar devido ao processo inflamatório que adere o pulmão à pleura parietal associado a espessamento e irregularidade da linha pleural. No entanto, as linhas B do padrão congestivo geralmente acometem de forma bilateral e há o deslizamento pulmonar normal, definido como um movimento horizontal, de vaivém, começando na linha pleural e sincrônico com a respiração. Esse último achado é definido como perfil B (28).

O perfil B é útil para rastrear mudanças dinâmicas na congestão pulmonar em resposta ao tratamento, e sua persistência em paciente ambulatoriais clinicamente estáveis com IC é preditiva de hospitalização e mortalidade (28). Atualmente, o ajuste do diurético é baseado nos sintomas, achados do exame físico, débito urinário e perda de peso. Porém a detecção de sinais de congestão dependente do exame clínico possui alta variabilidade inter-observador e, além disso, o volume urinário e peso possuem fatores confundidores sujeitos a erro. Consequentemente, o paciente pode receber subdoses ou doses excessivas de diurético com potencial aumento de morbidade e maior chance de reinternação precoce (29-31).

Em um estudo realizado em dois hospitais acadêmicos de Glasgow e Boston para avaliação de prevalência e importância prognóstica do US pulmonar, foi identificado que pacientes com maior número de linhas B eram mais velhos e uma classe funcional pela NYHA (*New York Heart Associaton*) mais alta. Além disso, apresentaram mais sinais de congestão pulmonar no RX de tórax e maior valor do NT-pro-BNP. Associado a isso, não havia diferenças significativas da relação de linhas B com doenças prévias como insuficiência renal, DPOC ou história de cardiopatia isquêmica (30). Outro estudo, que comparou congestão clínica com avaliação de veia cava inferior (VCI),

demonstrou que em 90% dos pacientes com dilatação maior que >20 mm também tinham sinais clínicos de congestão e, além disso, houve correlação com maior risco de hospitalização por IC e mortalidade (14).

Meta-análise realizada em 2015 que recrutou 1914 pacientes demonstrou que o perfil B identifica dispneia de origem cardiogênica com sensibilidade de 85% e especificidade de 92%, superior ao derrame pleural e ao ecocardiograma, e comparável aos peptídeos natriuréticos (34). Miglioranza *et al* avaliaram a relação de dosagem de NT-pro-NBP e US pulmonar. Quando utilizando-se ponto de corte de NT-proBNP >1,000 pg/ml os pacientes com valor acima deste apresentavam um número significativamente maior de linhas B comparado com os pacientes que não atingiam o valor de corte (54 ± 36 vs. 17 ± 17; $p < 0.0001$). A curva ROC destes achados demonstrou uma sensibilidade de 86,5% e especificidade de 73,3% (32).

O papel da congestão subclínica é relevante nos desfechos ambulatoriais de pacientes com IC. O reconhecimento e sua quantificação são cruciais na avaliação destes indivíduos porque o ajuste imediato do tratamento pode reduzir morbidade e mortalidade (31). Nesse contexto, uma avaliação mais precisa do grau de congestão do US pulmonar pode permitir uma melhor titulação terapêutica e avaliação prognóstica (33).

JUSTIFICATIVA

Congestão é uma causa importante de sintomas e de hospitalizações na IC, sua avaliação acurada pode ser difícil e seu reconhecimento clínico impreciso. É importante ressaltar que a avaliação de congestão pulmonar e sistêmica são imprescindíveis para o tratamento adequado desses pacientes e a US pulmonar pode auxiliar nessa avaliação, já que o exame clínico tem baixa sensibilidade. Adicionado a isso, grande parte destes indivíduos permanece utilizando as mesmas doses de diurético de forma crônica, e seu ajuste em pacientes estáveis ainda é uma prática infrequente, principalmente naqueles aparentemente euvolêmicos pela avaliação clínica. No entanto, sabe-se que existem efeitos adversos relacionados a altas doses de furosemida como piora da função renal podem estar associados a maior risco de hospitalização e morte. Além disso, a dosagem errada dessa medicação prejudica a otimização terapêutica com o uso de medicamentos que reduzem desfechos duros como mortalidade.

Com base nisso, o presente estudo busca avaliar se a incorporação do US à consulta ambulatorial de pacientes com IC pode auxiliar na tomada de decisões quanto ao ajuste no uso de diuréticos. Ainda, avaliaremos os desfechos após ajuste medicamentoso baseado na primeira consulta guiada por exame clínico associado ao US pulmonar. Será avaliada a modificação da classe funcional, internação por IC e óbito. Também realizaremos uma análise dos fatores de risco associados a piores desfechos após a avaliação com a US pulmonar, uma vez que existem alguns perfis de pacientes com maior número de linhas B como idosos, classe funcional NYHA mais elevada (30) e maior massa ventricular esquerda (11).

OBJETIVOS

OBJETIVO GERAL

Avaliar se mudanças nas decisões de ajuste de diurético, influenciadas pela avaliação de congestão pela US pulmonar em adição ao exame clínico se associam a desfechos clínicos em médio prazo incluindo mudança na classe funcional, internação por IC e óbito.

OBJETIVOS ESPECÍFICOS

1. Avaliar os fatores de risco associados a piora da classe funcional, internação por IC e óbito após a avaliação com a US pulmonar.
2. Avaliar a concordância da congestão pulmonar detectada pela avaliação clínica e sua relação com a US pulmonar.

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ARTIGO EM INGLÊS

LUNG ULTRASOUND EVALUATION IN OUTPATIENTS WITH HEART FAILURE IN A TERTIARY HOSPITAL AS A IN DECISION-MAKING AND PROGNOSTIC TOOL

ABSTRACT

Background: Heart failure (HF) is a chronic disease whereas treatment of pulmonary and systemic congestion is an important therapeutic target, but clinical examination alone is not sensitive nor specific and may fail to adequately detect congestion in outpatients.

Objective: To evaluate whether lung ultrasound (LUS) assessment of congestion, in addition to clinical examination, changes congestion detection and diuretic adjustment decisions in outpatients with HF, and whether it is associated with medium-term clinical outcomes including change in functional class, hospitalization for HF and death.

Methods: This is a retrospective and observational study of adult outpatients with chronic HF, NYHA functional class II–IV. During regular clinical visits, evaluation of congestion and Clinical Congestion Score were performed and decision regarding diuretic adjustments were done. Blinded assessment of B-lines was then performed, and the number of B-lines reported to medical team. Then, adding LUS data to clinical information, final decision on diuretic adjustment was defined. Posteriorly, a review of the medical record was carried out after a medium follow up of 24.6 ±14.2 months to assess outcomes after diuretic therapy adjustment based on pulmonary US and CCS findings.

Results: Between April and November 2019, 239 patients were included and a total of 204 patients were analyzed in the follow up (62 (±13) years; 66% males). Mean left ventricular ejection fraction was 33% (±11). Most patients were in NYHA II or III (79%) and the median CCS was 3.98 (±2.5) points. In LUS evaluation, patients had a median of 6 B-lines (1-20). The prescription of diuretics was modified in 75 (36.7%) of the cases after the ultrasound data, compared to decision before LUS evaluation. Patients whose diuretic dose was increased after LUS had a higher risk of hospitalization for HF and death with a *hazard ratio* of 1.6 (CI 1.01 – 2.66, p = 0.04). In clinical follow-up, patients congested by CCS had higher mortality than non-congested [25 (18%) vs. 5 (7%), p<0.0001) with hazard ratio (HR) 2.7 (CI 95% 1.1-7.1, p=0.03). Congested patients identified by LUS had a higher mortality [26 (26%) vs. 4 (4%), p<0.0001)] HR 7.1 (CI 95% 2.4-20.2, p< 0.001). Patients with clinical and LUS congestion had a higher mortality [23 (77%)] than patients with only congestion by the

CCS alone [2 (7%)], by LUS alone [3 (10%), and in relation to non-congested [2 (7%)], with *hazard ratio* of 7.6 (CI 95% 1.8-32.4, p = 0.006).

Conclusion: The identification of B-lines by LUS added to clinical assessment changed congestion classification and modified the clinical decision of diuretic adjustments in more than a third of HF outpatients. Although results from large-scale randomized clinical trials are needed to clarify whether a B-line –guided approach could contribute of reducing HF morbidity and mortality, the presence of pulmonary congestion might help to optimize the treatment of congestion in outpatients with HF.

Keywords: heart failure, pulmonary congestion, lung ultrasound, diuretics, B-lines.

BACKGROUND

Heart failure (HF) is one of the leading causes of hospitalizations in the US in adults older than 65 years (1). Pulmonary congestion is the main cause of hospitalizations in patients with HF, which is associated with higher rates of re-hospitalizations and mortality (2–4). Due to the chronicity of HF, pulmonary congestion develops gradually (6). Pulmonary auscultation findings, which are subject to the respective examiner's subjectivity, may often be attenuated or absent due to the adaptive process of the lymphatic system when reacting to the congestion (9), to the extent that only 4% of patients present these findings (5). Therefore, the clinical symptoms of congestion are not very sensitive or specific (6), having high inter-observer variability. Diuretic therapy, in particular loop diuretics, is the standard way to control congestion in association with optimal medical therapy, which provides symptomatic relief (10). An incorrect assessment of a patient's volume profile may lead to under or excessive doses of diuretics being prescribed, impacting morbidity and increasing the chance of early readmission (7-10).

Lung ultrasound (LUS) is a tool that has gained greater attention in the assessment of the volume profile of patients with HF due to its high availability, fast learning curve and low intra- and inter-observer variation (11). The short time required for execution, feasibility and simplicity make it possible to be easily performed during a routine outpatient visit, as an extension of the physical examination (12). This technique is based on the identification of vertical hyperechoic lines that originate in the pleura in a pattern similar to that of a “comet tail.” The number of B lines identified can be quantified, which is a good indicator of the presence of pulmonary congestion (13). The evaluation of the volume profile and quantification of these B lines allow for the tracking of dynamic changes in pulmonary congestion, in response to treatment (14). The persistence of the congestion pattern in clinically stable outpatients with HF is associated with the risk of hospitalization and mortality (14).

The assessment of pulmonary congestion can help guide the treatment of outpatients with HF and the prognostic stratification. However, the feasibility of this tool, its impact on the therapeutic decision and the prognosis in our setting is still unknown. This study aims to assess whether the quantification of B lines associated

with clinical examination is capable of promoting changes in diuretic adjustment decisions and whether it is capable of indicating the prognosis in the medium-term.

METHODS

This study consists of a retrospective study that will evaluate the patient's outcome after the adjustment of diuretic therapy based on LUS findings and the clinical congestion score (CCS) in a previous consultation regarding a change in the functional class, hospitalization due to HF and death. The association of these outcomes according to the baseline characteristics of the patients will also be assessed, since there are some profiles of patients with a greater number of B lines such as the elderly, higher NYHA functional class (8) and greater left ventricular mass (15).

The protocol was approved by the research ethics committee of the Hospital de Clínicas de Porto Alegre. The study was conducted in accordance with the principles of the Declaration of Helsinki and the informed consent form (ICF) was obtained from all patients enrolled.

Study Population

Patients diagnosed with HF treated at a dedicated outpatient clinic at Hospital de Clínicas de Porto Alegre between April and November 2019 were included. The diagnosis of HF was performed using the Framingham criteria in the outpatient assessment or during a previous hospitalization due to decompensation with a subsequent referral to the outpatient clinic. The follow-up was performed by reviewing the medical records of patients initially included who maintained their outpatient follow-up appointments. A total of 239 individuals were enrolled in the study and following reassessment of the baseline study, with the data being updated through January/2022 with the follow-up complete, 204 (85.3%) patients were included. The inclusion criteria were ages between 18 and 90 years with NYHA functional class of II-IV, regardless of ejection fraction (EF) or HF etiology. The exclusion criteria include a previous diagnosis of pulmonary fibrosis or chronic kidney disease being treated with hemodialysis.

Study Protocol

The patients underwent routine consultations, where they were attended by a team of physicians who performed the standard consultation with medical intake and physical examination, in addition to the analysis of laboratory and imaging tests available. The previously validated CCS was used, adding the signs and symptoms of HF values obtained in the clinical evaluation, which consisted of: functional class, orthopnea and paroxysmal nocturnal dyspnea, edema, peripheral edema, pulmonary rales, presence of B3, hepatojugular reflux and increased central venous pressure. Congestion grades were defined as: no congestion (0-2 points), mild congestion (3-4 points), and moderate to severe congestion (5 or more points).

Afterwards, the medical team made a determination as per whether to maintain the therapy that the patient was using or whether to change a certain part of the treatment. At this time, the patient was screened for study enrollment. If accepted, the ICF was signed and the patient was submitted to a pulmonary congestion assessment by LUS.

The US images were performed by a trained investigator, who was blinded to the patient's previously recorded clinical information. A Sonosite portable ultrasound device with a convex transducer was used. Images were recorded at twenty-eight thoracic sites (sixteen sites in the right hemithorax and twelve sites in the left hemithorax). A standardized imaging protocol was followed with the transducer perpendicular to the ribs with an imaging depth of 16 cm, while the patients were assessed in the supine position. The congestion grades were defined as: no congestion (0-5 B lines), mild congestion (6-15 B lines), moderate to severe congestion (15 or more B lines).

After performing the LUS, the number of B lines was reported to the medical team treating the patient after they had determined the diuretic dose with standard medical care. Finally, adding the clinical information to the US findings, the medical team decided whether to maintain the treatment previously defined prior to the LUS being performed or to modify its decision regarding the diuretics prescribed after obtaining the assessment of the pulmonary congestion. Other clinical and demographic information was also collected from the patient's medical record.

A review of the medical records was carried out in January/2022 of the patients included in a previous study conducted in the master's thesis of Dr. Simone Louise Savaris to assess outcomes following adjustment of the diuretic therapy or not, based on LUS and CCS findings.

Outcomes

The primary outcome was defined as the medication adjustment based on the first consultation guided by the clinical examination associated with LUS regarding improvement or not in the functional class, hospitalization due to HF, and death.

Secondary outcomes were defined as the presence of ultrasound congestion, agreement with the CCS and prognostic association of the pattern of congestion with hospitalization due to HF and death.

Statistical analysis

The master's thesis estimated a prevalence of congestion around 20% with 5% of discordance between clinical evaluation and lung ultrasound. Considering a power of 90% and an alpha error of 0.05, were estimated a required sample size of 228 patients. Data collection from the baseline study was carried out between April and November 2019 and an additional review of the medical records was carried out in January/2022. Continuous variables were reported as mean ± standard deviation (SD) or median and interquartile range (IQR), where applicable. Categorical variables were reported as a number and percentage. Comparisons between groups were analyzed using Student's t test (continuous normal variables) or the chi-square test (categorical variables). Follow-up time was defined as the date from the index outpatient visit to the last outpatient visit or date of the outcome of interest. The agreement between the CCS and the LUS findings was calculated using the Kappa coefficient of agreement. The association of congestion findings through CCS and LUS with the outcome of hospitalization due to HF and death was assessed using the Cox proportional hazards model. Kaplan-Meier survival curve analysis was used to determine the differences between those without congestion, CCS congestion only, LUS congestion only, or congestion detected by both

methods. Generalized linear models were used to calculate the odds ratio for the association of clinical variables related to the presence of LUS congestion. Statistical significance was established for a P value less than 0.05 for primary and secondary outcomes. Statistical analysis was performed using the SPSS v25.0 software.

RESULTS

Of the 204 patients included, the mean age was 62 (±13) years, most were male (66%), white (72%) and left ventricular ejection fraction was 33±11%. The main etiology of HF was ischemic heart disease (37%) followed by idiopathic heart disease (30%). The most common comorbidities were hypertension (57%), diabetes mellitus (40%) and coronary artery disease (39%). Most patients were in NYHA class II or III [161 (79%)] and the median CCS was 3.98 ±2.5 points. Table 1 summarizes the clinical data of the included patients.

Table 1. Baseline Characteristics of Included Patients

	(n = 204)
Age	62±13
Male	135 (66%)
Ethnicity	45 (67%)
White	148 (72%)
Black	32 (16%)
Other	24 (12%)
NYHA Functional Class	
NYHA I	41 (20%)
NYHA II	111 (54%)
NYHA III	50 (25%)
NYHA IV	2 (1%)
Ejection Fraction (%)	33% ±11
HF Classification	
HFpEF	21 (10%)
HFmrEF	25 (12%)
HFrEF	158 (78%)

LV diastolic diameter	61 (57-67)
HF etiology	
Ischemic heart disease	72 (37%)
Idiopathic heart disease	61 (30%)
Other	69 (33%)
Comorbidities	
Systemic arterial hypertension	116 (57%)
Diabetes Mellitus	83 (41%)
Coronary artery disease	78 (38%)
Atrial fibrillation	63 (31%)
Pharmacological Treatment	
Beta-blocker	196 (97%)
ACEi/ARB/ARNI	163 (81%)
Furosemide	169 (83%)
Spironolactone	110 (55%)
Nitrate	72 (36%)
Hydralazine	51 (25%)
Digoxin	82 (41%)
Thiazide Diuretic	24 (12%)
Devices	
Implantable cardioverter-defibrillator	47 (23%)
Resynchronization pacemaker	8 (4%)
Laboratory Exams	
Creatinine (mg/dL)	1.2 (1.0-1.6)
Sodium (mEq/L)	140±3
Potassium (mEq/L)	4.4±0.5
NT-Pro-BNP (pg/mL)	1593 (676-4.524)
Congestion	
Clinical Congestion Score (CCS)	3.98±2.5
Number of B lines	6 (1-20)

Data are expressed as number (%), mean (± standard deviation) or median (interquartile range), where applicable. HFpEF, heart failure with preserved ejection fraction; HFmrEF, heart failure with mildly reduced ejection fraction; HFrEF, heart failure with reduced ejection fraction; ACEi, angiotensine-converting enzyme inhibitor; ARB,

angiotensine-recpetor blocker; ARNI, angiotensine-receptor neprilisina-inhibitor; CCS, Clinical Congestion Score; LUS, lung ultrasound; LVEF, left ventricular ejection fraction; NYHA, New York Heart Associaton.

Congestion Assessment

The assessment using the CCS identified 68 (33%) patients classified as non-congestive (< 3 points) and 136 (67%) congested (≥ 3 points). Congested patients by CCS had a greater number of B-lines on lung US compared to non-congested patients [8 (24) vs. 2 (9), P< 0.001]. In the LUS assessment, the patients had a median of 6 (1-20) B lines, with 102 (50%) classified as being without ultrasound congestion, 43 (21%) with mild congestion and 59 (29%) as moderate to severe congestion. Table 2 presents the classification of congestion by LUS according to the congestion by CCS. There was a predominance of patients with a higher degree of congestion by LUS in those with clinical congestion assessed by the CCS (P=0.001). The majority of the patients without congestion had no B-lines in the LUS 46 (68%), however 56 (41%) of the patients classified as clinically congested did not have ultrasound congestion. In addition, 10 (15%) of those without congestion in the CCS, had moderate to severe congestion in the LUS. The assessment of agreement between the two methods by calculating the Kappa coefficient between those with clinical congestion (CCS≥ 3 points) and ultrasound congestion (≥5 lines B) identified only a slight Kappa agreement of 0.201 (P=0.004).

Table 2 – Characteristics of LUS between congested and non-congested based on the Clinical Congestion Score

	CCS<3 (N = 68)	CCS≥3 (N = 136)	P
Number of B lines	2 (9)	8 (24)	<0.001
Congestion score based on LUS			0.001
0 - no congestion	46 (68%)	56 (41%)	
1– slight	12 (18%)	31 (23%)	
2 – moderate to severe	10 (15%)	49 (36%)	

CCS, clinical congestion score; LUS, lung ultrasound

Figure 1 demonstrates the congestion classification by CCS and LUS, as well as the changes that occur in each group when combining the two methods.

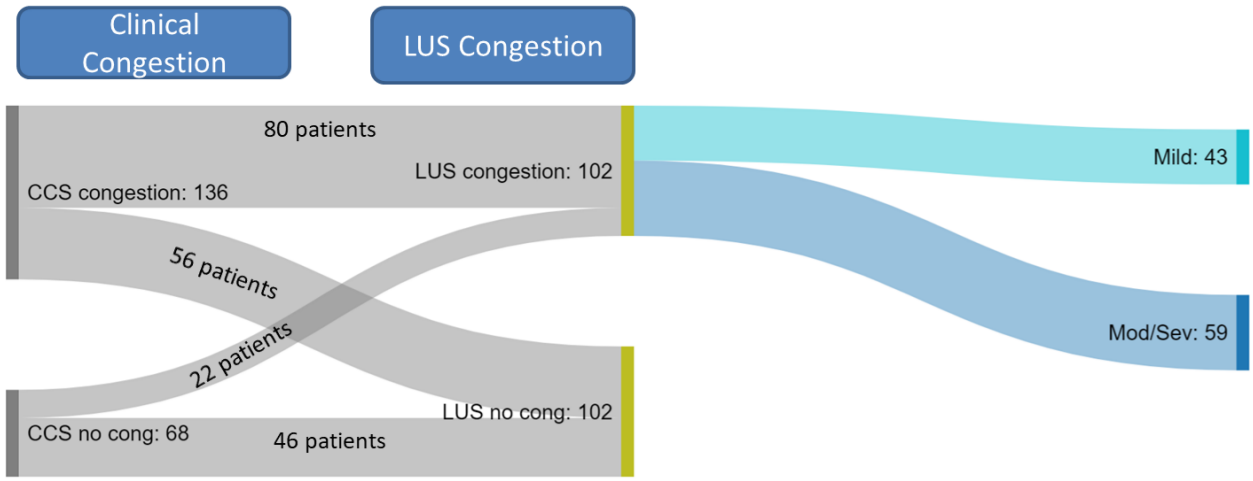


Figure 1. Sankey curves demonstrating congestion evaluation by CCS and LUS. It shows the change in congestion degree when adding LUS information to clinical evaluation. (CCS, Clinical congestion score; LUS, lung ultrasound)

Diuretic therapy

Prior to the information obtained by LUS in the baseline study, the decision regarding diuretic adjustment was to increase the dose or add another diuretic in 44 (21.6%) patients, to maintain the dose in 141 (69.1%) and reduce it in 19 (9.3%). After receiving information regarding the number of B lines, the final diuretic prescription was modified in 75 (36.7%) cases. Of these, 41 (55%) had an increase in the diuretic dose compared to the decision before the LUS result, 21 (28%) had the dose adjusted downwards and 13 (17%) maintained the dose, while the pre-LUS decision would be to change the dose. Figure 3 and 4 summarizes the diuretic prescription changes according to the findings in the LUS.

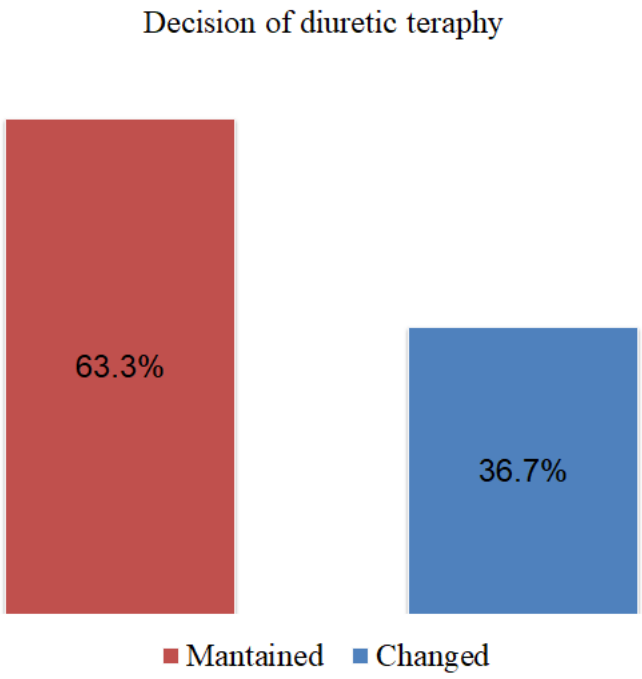


Figure 3. Decision of diuretic doses prescription after LUS.

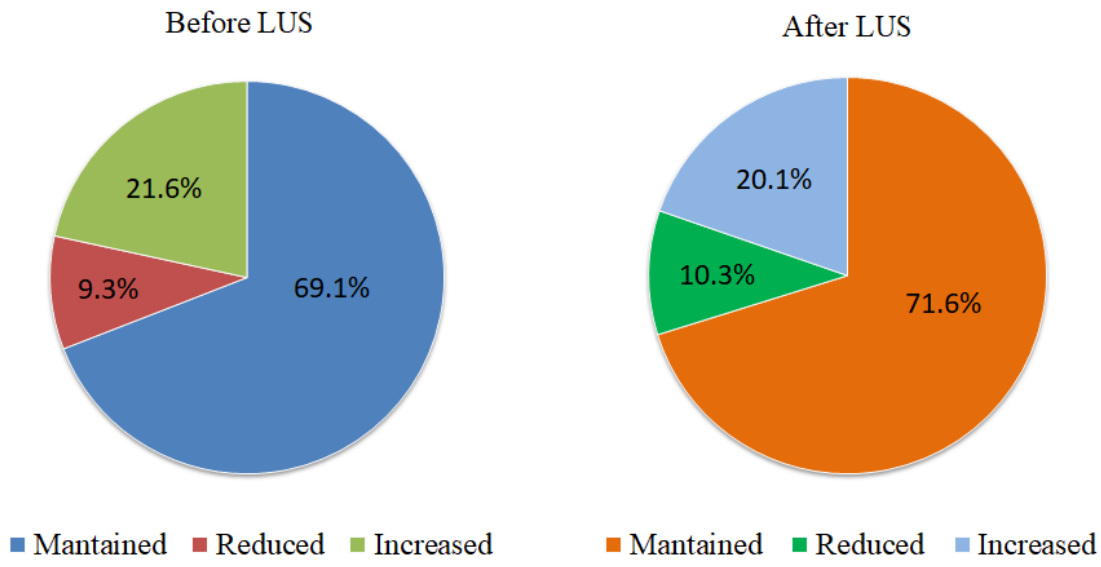


Figure 4. Change in diuretic doses prescription after LUS compared to prescription after usual medical care. (LUS, lung ultrasound)

After LUS-based medication adjustment, there was no significant difference with regard to HF hospitalization (p = 0.849). However, patients in whom the diuretic dose was increased had a borderline result in terms of mortality with *hazard ratio* (HR) of 2.08 (CI 0.96-4.52, P =0.062). When assessing the combined outcome of hospitalization for HF and mortality, patients who had an increase in the diuretic dose also had a higher risk of the outcome with a HR of 1.6 (CI 1.01-2.66, P = 0.04).

Clinical follow-up

Patients included in the study had a follow-up period on average of 24.6 ± 14.2 months. Patients congested by the CCS scale had a higher rate of readmission due to HF 61 (45%) than those without congestion 26 (38%), however this did not result in a statistical difference (P=0.36). However, congested patients had higher mortality than non-congested patients based on the CCS scale [25 (18%) vs. 5 (7%), P<0.0001] with a HR of 2.7 (CI 95% 1.1-7.1, P=0.03). In the LUS assessment, congested patients demonstrated a tendency towards having a higher rate of hospitalization due to HF than non-congested patients [58 (57%) vs. 29 (28%), P<0.0001] with HR of 1.5 (CI 0.9-2.4,

P=0.06). However, congested patients had higher mortality than non-congested patients assessed by LUS [26 (26%) vs. 4 (4%), P<0.0001)] with a HR of 7.1 (95% CI 2.4-20.2, P<0.001), as shown in Table 3.

Table 3 – Clinical follow-up regarding hospitalization due to HF or death between congested and non-congested according to the Clinical Congestion Score and lung ultrasound

	Clinical congestion					
	No (N = 68)	Yes (N = 136)	P	HR	95% CI	P
Hospitalization due to HF	26 (38%)	61 (45%)	0.36	0.9	0.5-1.5	0.77
Death	5 (7%)	25 (18%)	<0.0001	2.7	1.1-7.1	0.03
	Ultrasound congestion					
	No (N = 102)	Yes (N = 102)	P	HR	95% CI	P
Hospitalization due to HF	29 (28%)	58 (57%)	<0.0001	1.5	0.9-2.4	0.06
Death	4 (4%)	26 (26%)	<0.0001	7.1	2.4-20.2	<0.001

Afterwards, we performed a stratified analysis based on the absence of congestion by the two methods, presence of clinical or ultrasound congestion alone, and congestion present in both methods for hospitalization due to HF and mortality. Patients with clinical and ultrasound congestion had a higher rate of hospitalization due to HF [47 (54%)] than patients with only congestion by the CCS scale alone [14 (16%)], by LUS alone [11 (13%)], and in relation to non-congested [15 (17%)], (P=0.001). However, the different patterns of congestion showed no association with hospitalization due to HF in the logistic regression model with odds ratio of 1.2 (CI 0.7-2.2, P = 0,53), as shown in Figure 3A.

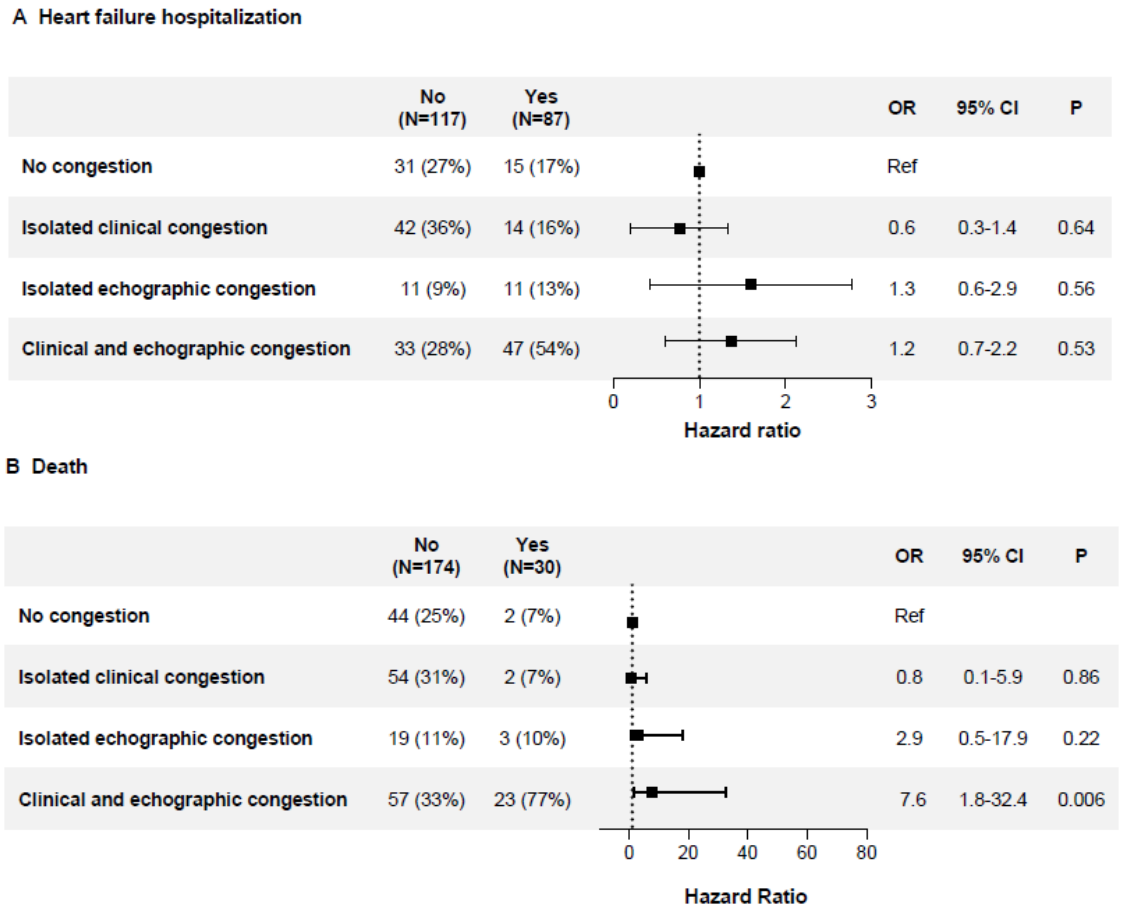
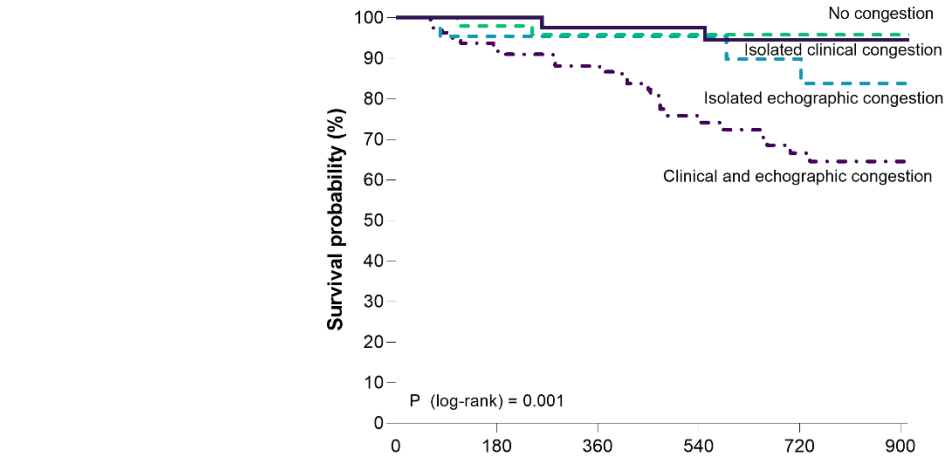


Figure 3. Forest blot chart demonstrating clinical follow-up in relation to hospitalization due to HF and death in the subgroups without congestion, clinical congestion, echocardiographic congestion and the combination of the methods.

The evaluation of mortality according to the degree of clinical and ultrasound congestion showed a lower rate of events in those without congestion [2 (7%)], followed by those with only clinical congestion [2 (7%)], only LUS congestion [3 (10%)], and higher mortality rate in those with clinical and LUS congestion [23 (77%)], P=0.001. The latter is an important predictor of mortality with an HR of 7.6 (1.8-32.4), P=0.006 (Figure 3B). Afterwards, we performed a survival analysis using the Kaplan-Meier curve for the respective patterns of congestion and mortality. The result showed different survival probabilities according to the interaction of the clinical congestion score and ultrasound congestion (P log-rank=0.01), mainly in those with congestion identified by both methods (Figure 4).



Number at risk						
No congestion	46	40	37	33	29	2
Isolated clinical congestion	56	47	44	40	35	6
Isolated echographic congestion	22	21	18	17	15	3
Clinical and echographic congestion	80	67	61	45	33	11

Figure 5. Kaplan-Meier curve for the mortality outcome in relation to subgroups without congestion, clinical congestion, echocardiogram congestion and the combination of both methods.

Due to the increase in terms of prognostic stratification of lung ultrasound findings in patients with HF, we verified which clinical characteristics were associated with LUS as predictors of pulmonary congestion. As shown in Table 4, it is observed that ages over 65 years (OR 1.7, 95% CI 0.9-3.0, P = 0.05) and functional class [NYHA II, OR 3.4 (CI 1.5-7.6, P = 0.003), NYHA III/IV, OR 5.8 (CI 2.3-14.6, P < 0.001)] were predictors of LUS congestion.

Table 4 – Clinical variables associated with the presence of pulmonary congestion observed in the LUS

	Ultrasound congestion			OR	95% CI	P
	No (N=102)	Yes (N=102)	P			
Age ≥ 65 years	42 (41%)	56 (55%)	0.05	1.7	0.9-3.0	0.05
Male	69 (68%)	66 (65%)	0.65	1.1	0.6-2.0	0.65
NYHA			<0,001			
I	31 (30%)	10 (10%)		Ref.		
II	53 (52%)	58 (57%)		3.4	1.5-7.6	0003
III/IV	18 (18%)	34 (33%)		5.8	2.3-14.6	<0,001
HTN	453 (52%)	63 (562%)	0.15	1.5	0.8-2.6	0.15
DM	39 (38%)	44 (43%)	0.47	1.2	0.7-2.1	0.47
CAD	35 (34%)	43 (42%)	0.24	1.4	0.8-2.4	0.25
COPD	12 (12%)	15 (15%)	0.53	1.3	0.6-2.9	0.53
Active smoking	9 (9%)	12 (12%)	0.48	1.4	0.5-3.4	0.49
Obesity	12 (12%)	8 (8%)	0.34	0.6	0.2-1.6	0.34
Atrial fibrillation	29 (28%)	34 (33%)	0.44	1.2	0.7-2.3	0.44
Ischemic etiology	31 (30%)	41 (40%)	0.14	1.5	0.8-2.7	0.14
Non-ischemic etiology	71 (70%)	61 (60%)	0.14	0.6	0.4-1.1	0.14

NYHA, New York Heart Association; HTN, hypertension; DM, diabetes mellitus; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; LUS, lung ultrasound

DISCUSSION

In this retrospective study of LUS to assess pulmonary congestion in outpatients with HF, the addition of LUS assessment enabled the identification of outpatients with congestion despite the absence of clinical signs, proving that the US is more sensitive for detecting lung congestion. Added to that, LUS information resulted in a change in diuretic adjustment in about one-third of patients. Furthermore, patients who had the diuretic dose increased after evaluation by LUS were more likely to be hospitalized for HF and death. Patients with congestion identified by LUS had greater mortality than those with clinical congestion alone. Finally, the presence of congestion by both methods was associated with a worse prognosis in this population.

Congestion symptoms in patients with HF may fluctuate with periods of improvement and worsening according to volumetric status (3). Weight gain before admission is found in only a minority of patients with HF, which is a sign of low sensitivity (9). Furthermore, natriuretic peptides may be inaccurate in signaling decompensation in this type of patient, as NT-pro-BNP levels are often elevated in patients with stable HF. Therefore, other methods became necessary to control the fluid status of patients with HF (9). Detecting pulmonary congestion, especially in the early stages of decompensation in patients with chronic HF, as in the case of the population of the present study, can be challenging. The CCS was developed to better characterize hypertension in outpatients with HF that are considered to be congested when they present ≥3 points, correlating with worsening survival and greater morbidity (16).

Miglioranza *et al*, demonstrated that a number of B lines ≥15 was significant to identify patients with pulmonary congestion and this cutoff was associated with increased risk of needing emergency care, hospitalization due to HF, and mortality (17). Previous studies suggest that outpatients with HF who present rattling during pulmonary auscultation have a higher risk of hospitalization and death (18,19). However, auscultation findings are qualitative, subjective, and often absent in the outpatient clinic. Chronic patients, in which adaptive processes of the lymphatic system reduce the presence of alveolar edema, result in lower sensitivity for this finding (5). Martindale *et al* demonstrated that profile B has a sensitivity of 85% and a specificity of 92%, superior to pleural effusion and echocardiography and comparable to natriuretic

peptides in identifying dyspnea of cardiogenic origin (13). In recent years, LUS has gained greater attention in patients with HF due to its high availability, rapid learning curve and low intra- and inter-observer variation (11). Due to its fast execution and 100% feasibility and simplicity, this technique is able to be easily performed during a routine outpatient visit as an extension of the physical examination (12). There is a scarcity of data in the literature on the use of LUS in the assessment of pulmonary congestion in outpatients with HF and on how it aids the therapeutic decision regarding the use of diuretics.

In our study, 15% of patients without congestion in the clinical examination had moderate to severe congestion in the LUS. Therefore, this method has the ability to detect subclinical congestion, including in outpatients with chronic HF. In this manner, lung US helps in the titration of diuretic doses, promoting an improvement in the functional class, reduction of adverse effects and hospitalizations (20). In addition to this, the LUS congestion assessment resulted in diuretic dose modification in more than 36% of cases compared to what had been determined based on the clinical assessment alone. The final dose of loop diuretic was not only higher than the dose used before the consultation, but it was also higher than that determined after standard medical care. It was also seen that there was an increase in hospitalization due to HF and mortality in patients whose diuretic dose was increased based on the LUS data, this result probably reflects the greater severity of HF in this group of patients and, therefore, the greater need for the use of diuretics and risk of death. A previous study randomized 123 patients to assess the usefulness of LUS in the follow-up period up to 180 days after hospital discharge in patients who were hospitalized due to HF. This study demonstrated that patients received follow up visits using LUS had a lower rate of decompensation and an increase in the distance covered by the 6-minute walk test due to the higher dose of diuretic prescribed (13). Thus, our data corroborate that LUS in the outpatient setting not only allows the identification of congested patients, but also has the ability to modify therapy with an impact on outcomes.

Platz *et al* assessed 195 NYHA II-IV outpatients and demonstrated that there is a fourfold increased risk of hospitalization due to HF and death from any cause with a positive relationship with the increase in B lines identified during a 6-month follow-up regardless of age, gender, and functional class by NYHA or CCS (5). In our study, in a

mean follow-up of 2 years, there was a tendency for patients with CCS congestion to have a higher rate of readmission due to HF than those without clinical congestion, however this did not demonstrate a statistical difference. Nevertheless, patients congested by CCS had a higher risk of mortality than non-congested patients. On the other hand, the presence of pulmonary congestion assessed by LUS showed borderline results for hospitalization due to HF and was associated with mortality, which corroborates previous data in the literature (2-5,12,8-9,17). Furthermore, it was possible to identify that the presence of clinical and ultrasound congestion was associated with a worse prognosis. Borderline data regarding the presence of congestion in the LUS may only reflect a lack of power due to the sample size, but there is a gradient of severity in relation to absence of congestion, isolated clinical congestion, isolated ultrasound congestion and by both methods, respectively.

Although results from large-scale randomized clinical trials are needed to clarify whether a B-line-guided approach could contribute to reducing HF morbidity and mortality, the presence of pulmonary congestion may serve as an alarm to optimize the treatment of outpatients with HF and intensify its follow-up with the objective of reducing the number of hospitalizations. The present study demonstrated that the ultrasound assessment of the pulmonary congestion pattern, in addition to helping in the decision of diuretic therapy, demonstrated prognostic capacity in relation to mortality in a mean follow-up period of 24 months.

This study does present certain limitations. Drug therapy after LUS was at the discretion of the attending team, as a treatment protocol based exclusively on ultrasound findings was not created. This is due to the fact that the medical team always obtained clinical information concerning congestion before learning about LUS findings, and the number of B lines was added to the standard medical care for congestion assessment. This is a cross-sectional study in which there was no comparison group, therefore, we hypothesized that diuretic management with the aid of LUS would imply a short-term prognostic benefit, however, more robust studies are needed to confirm this strategy. The sample size may have influenced the results related to the clinical and ultrasound congestion subgroups.

In conclusion, the identification of B-lines by LUS in addition to the clinical assessment altered the classification of congestion and modified the clinical decision of doses of diuretics in more than one third of outpatients with HF. Furthermore, patients with congestion by the imaging method had a higher rate of mortality, thus proving to be a simple and easy-to-use tool that helps in the clinical assessment of these patients.

CONFLICTS OF INTEREST

The authors did not report conflicting relationships or interests that could be interpreted as a conflict of interest.

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CONCLUSÃO E CONSIDERAÇÕES FINAIS

A IC é uma patologia de saúde pública, suas elevadas taxas de morbimortalidade estão intimamente relacionadas às internações por descompensações desencadeadas por congestão. Apesar dos avanços tecnológicos no tratamento dessa síndrome, a qualidade de vida dos pacientes que possuem IC, independente da etiologia, é reduzida. O manejo dos diuréticos é fundamental para evitar hospitalizações e evitar efeitos adversos.

No paciente ambulatorial com IC, graduar congestão ainda é um desafio. O exame físico e o ECC são falhos devido à baixa sensibilidade e especificidade, e novos métodos são necessários para a sua melhor avaliação visto que é fator prognóstico para mortalidade e internação por IC.

No presente trabalho, a identificação de linhas B pelo US pulmonar demonstrou que mais de metade dos pacientes foram classificados de forma distinta pelo ECC e pela US pulmonar. Além disso, quando somada a avaliação clínica alterou a classificação de congestão e modificou a decisão clínica de doses de diuréticos em mais de um terço dos pacientes. Também se observou que houve aumento de internação por IC e mortalidade nos pacientes em que a dose do diurético foi aumentada baseado no uso do US, refletindo a necessidade de doses maiores de diuréticos e maior mortalidade quanto mais avançada a IC. No seguimento a médio prazo, foi possível identificar que a presença de congestão clínica associada a congestão ecográfica associou-se com pior prognóstico no que diz respeito a mortalidade.

A US pulmonar é uma ferramenta simples, de fácil utilização, altamente reprodutível e que apresenta impacto na avaliação da congestão, no tratamento diurético e no prognóstico a médio prazo em pacientes ambulatoriais com IC.

Estudos randomizados de larga escala são necessários para esclarecer se uma abordagem guiada pelas linhas B poderia contribuir para reduzir a morbidade e mortalidade por IC, porém a presença de congestão pulmonar pode servir de alarme para otimizar o tratamento dos pacientes ambulatoriais com IC.