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The social experience of uncertainty: a qualitative analysis of emergency department care for suspected pneumonia for the design of decision support

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Abstract

Background This study sought to understand the process of clinical decision-making for suspected pneumonia by emergency departments (ED) providers in Veterans Affairs (VA) Medical Centers. The long-term goal of this work is to create clinical decision support tools to reduce unwarranted variation in diagnosis and treatment of suspected pneumonia.

Methods Semi-structured qualitative interviews were conducted with 16 ED clinicians from 9 VA facilities demonstrating variation in antibiotic and hospitalization decisions. Interviews of ED providers focused on understanding decision making for provider-selected pneumonia cases and providers' organizational contexts.

Results Thematic analysis identified four salient themes: i) ED decision-making for suspected pneumonia is a social process; ii) the "diagnosis drives treatment" paradigm is poorly suited to pneumonia decision-making in the ED; iii) The unpredictability of the ED requires deliberate and effortful information management by providers in CAP decisionmaking; and iv) the emotional stakes and high uncertainty of pneumonia care drive conservative decision making.

Conclusions Ensuring CDS reflects the realities of clinical work as a socially organized process with high uncertainty may ultimately improve communication between ED and admitting providers, continuity of care and patient outcomes.

Keywords Diagnosis, Uncertainty, Social processes, Information management, Qualitative, Syndrome, Emergency department, Pneumonia, Infectious disease/infection, Decision support

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Background

Clinical decision support (CDS) refers to tools that "[improve] healthcare delivery by enhancing medical decisions with targeted clinical knowledge, patient information, and other health information" [1]. CDS typically takes the form of software-based recommendations or assessments available at the point of care and embedded within the electronic health record (EHR). CDS has long been viewed as a promising vehicle to improve quality and safety in healthcare by making it easier to follow evidence-based clinical practice guidelines (CPGs)



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[1–3]. The importance of understanding baseline clinical practice as a key feature of context for successful CDS design and implementation is well-recognized in clinical informatics [4–7], user-centered design [8–10], and implementation science [11–13]. Yet, CPGs that form the basis of CDS may not reflect a detailed awareness of the target clinical setting in which CDS will ultimately be implemented [2, 7]. An empirically grounded understanding of existing clinical workflows is likely to be especially important for adapting CPGs to CDS for healthcare systems with significant patient, resource or other differences between facilities; for clinical problems exhibiting high practice variation [5, 14, 15], and use cases with known adverse conditions that may impact clinical decision-making.

The emergency department (ED) is an example of a clinical setting that is crucial for many time-sensitive healthcare processes, but that is recognized to operate under distinct constraints [9, 15], with overcrowding and related time pressure being the ED's most commonly referenced problems [16]. Community acquired pneumonia (CAP) is a particularly common and consequential medical problem in the ED: CAP is responsible for 1.4 million ED visits annually in the US, [17] is the leading infectious cause of death in the United States, [18] is one of the most common reasons for emergency department (ED) encounters and hospitalization, [19] and is a top condition for which timely ED care impacts morbidity and mortality [20]. Swift and accurate diagnosis, disposition, and treatment are critical to optimal outcomes, [21] but treatment is often initiated under substantial diagnostic uncertainty [22].

Because of the ED's crucial role in treating large numbers of CAP patients, especially those patients at highest risk of mortality, CAP decision-making in the ED has long been the target of quality improvement. These efforts include the creation and dissemination of multiple evidence-based CPGs [21, 23–27]. While the use of CAP guidelines is consistently associated with better outcomes, [28–31] clinical practice continues to vary considerably, particularly around two decisions that have been identified by guidelines as opportunities for improvement:

- The initial disposition (whether to hospitalize or manage pneumonia in an outpatient setting): over 60% of all patients with pneumonia are admitted to hospital, although many of these patients have low illness severity [32–34].
- 2) Initial antibiotic treatment: nearly 1/3 of all hospitalized patients receive empiric treatment with broadspectrum antibiotics (with killing activity against methicillin-resistant *Staph aureus* or *Pseudomonas*

aeruginosa) despite a lack of evidence of benefit [35, 36].

CDS for CAP embedded in the electronic health record (EHR) has shown promise as a powerful tool to implement evidence-based practice, reduce unwarranted variation, and improve clinical outcomes. CDS for CAP often takes the form of severity index calculators and/or bundled order sets that allow pre-specification of labs and facility-preferred antibiotics [37-42]. However, our prior work suggests that when scaling beyond the facility that originates specific tools, adoption of CDS for CAP may be highly variable [43, 44]. Moreover, even when providers use CDS, they often deviate from CPG recommendations [43, 44]. While drops in effectiveness and adoption are common problems in the diffusion of clinical interventions into new contexts [45], the contributors to variation in ED provider approaches to pneumonia are not currently well understood [28, 35, 43, 46-52]. CAP decision-making in the ED is thus both a pressing problem for healthcare, and a useful research case for thinking through the relationship between CPGs, CDS and realworld clinical care.

This qualitative study sought to understand real-world clinical decision-making for CAP in the ED, a clinical problem with well-known practice variation [28, 35, 48–51] in order to 1) advance our understanding of mechanisms of practice variation, specifically in hospital admission and antibiotic decisions for CAP; and 2) inform the design of future CDS for ED pneumonia care that would be generalizable across different settings within a large national healthcare system.

Methods

Study Design: This was a qualitative study utilizing indepth semi-structured interviews to understand drivers of variation in decision-making around disposition, diagnosis and antibiotic selection for community acquired pneumonia among ED providers at VA Medical Centers. The study is reported in accordance with the COREQ reporting guideline [53]. The study was approved by the University of Utah and VA Salt Lake City Institutional Review Boards (IRB_00065268).

Participants and Recruitment: Sites were purposively selected based on quantitative analysis of variation in hospitalization decisions (hospital admission versus outpatient management) and antibiotic use (initial use of broad-spectrum antibiotics, defined as those with killing activity against methicillin-resistant *Staph aureus* or *Pseudomonas aeruginosa*, for hospitalized patients). Included sites were drawn from the upper and lower quartiles of antibiotic use based on system-wide VA data. Sites were also split between high- and low-complexity facilities, based on VA classification [54]. All included facilities were VA Medical Centers with academic affiliations. Participants were recruited through VA site liaisons and included medical doctors, doctors of osteopathy, nurse practitioners, or advanced practice providers who cared for patients in the ED. Interviews were scheduled and conducted in person during site visits to the facility with the exception of two interviews that were conducted by phone due to pandemic travel restrictions.

Data Collection: Semi-structured qualitative interviews were conducted with ED clinicians about their practices surrounding pneumonia care. A semi-structured interview guide was designed with input from a pulmonary critical care clinician and health services researcher (BJ), qualitative health services researcher (SZ), cognitive psychologist (CW), and health psychologist (JB). Interviews emphasized the goal of informing pneumonia decision support and included three components: i) a cognitive task analysis (CTA) of pneumonia diagnosis and disposition, including decision timing, EHR interactions and reasons for key decisions, and the construction and validation of a timeline for a specific incident of pneumonia care by the interviewee; ii) an assessment of institutional change relevant to pneumonia decision-making; and iii) individuals' knowledge, beliefs and self-efficacy related to clinical care for pneumonia. Interviews were conducted in-person by the study PI (BJ) between June 2019 and February 2020. Interviews were designed to take 45 minutes each. The interview guide has not been published elsewhere, and is provided as a supplemental file "Pneumonia decision making interview guide FINAL". Verbal informed consent to participate was obtained from all interviewees.

Data Analysis: Timelines from each interview were synthesized in a generalized timeline for ED CAP decision-making highlighting both the most commonly cited decisions in sequence, along with initially identified opportunities to provide CDS in the ED workflow. Audio recordings of interviews were transcribed by the VA Centralized Transcription Service Program. Transcripts were added to an Atlas.ti v9.0 qualitative database for analysis. Thematic analysis took a hybrid deductiveinductive approach. Memos and codes included a priori categories related to drivers of variation in pneumonia care (e.g. attitudes toward antibiotics and guidelines, as well as inpatient versus outpatient care capacity). A priori codes were informed by cognitive psychology theories of motivation, task feedback and information search as a theoretical basis for understanding providers' decision-making processes [55-61]. These a priori codes were augmented with codes to address emergent topics that appeared through review of interview content. Transcripts were iteratively reviewed by the PI (BJ)

and a sociocultural anthropologist and qualitative health researcher (PT) to familiarize themselves with the content, create memos and elaborate the codebook. Coding was conducted in weekly meetings, as well as through ad hoc meetings with the larger team (CW, JB, SZ) to provide input on codes as they were created and defined. The codebook was finalized via discussion among qualitative team members, building from memos (BJ, CW, SZ, JB, PT). Saturation was established through examination of diminishing returns in each analysis and discussion with the wider team about possible alternative interpretations of quotations and applications of codes. Once the full codebook was established, six interviews were doublecoded by one study team member (PT) and one research assistant overseen by the team's lead qualitative health researcher (SZ) to ensure consistency. The remaining ten interviews were coded by a sociocultural anthropologist (PT). Coded quotations were queried, iteratively reviewed, and discussed extensively by the qualitative research team (BJ, JB, CW, SZ, PT) to refine and aggregate them into salient themes that identified emergent and underappreciated aspects of the ED decision-making process for CAP. Results were shared with study participants to provide an opportunity for feedback on the analysis and interpretation of results.

Reflexivity Statement: This study was conducted by four white women (BJ, JB, CW, SZ) and one white man (PT), who were all employees of the VA at the time of the study. The PI served as an interviewer (BJ) and shares clinical training and work experience similar to those she interviewed. CW also has a clinical background. Guidance in theoretically informing the study design was primarily performed by two researchers with background in psychology (JB, CW). The qualitative analyst (PT) brought a non-psychology social science perspective that emphasized the distributed nature of clinical work in analyzing the transcripts. The research team did not have prior relationships with study participants.

Results

Practice patterns

Sixteen emergency providers from nine VA Medical Centers were included, with 6 and 4 from the upper and lower national quartile of hospitalization risk, and 6 and 5 from the upper versus lower national quartile of broadspectrum antibiotic use, respectively. Facilities sampled demonstrated an average (standard deviation) rate of hospitalization of $59 \pm 14\%$, initial use of anti-MRSA antibiotics of $29 \pm 10\%$, and initial use of antipseudomonal antibiotics of $31 \pm 7\%$. Table 1 summarizes individualand facility-level characteristics. A subset of de-identified qualitative data organized by code is provided in the Cumplementerer File "Dreumenie desision melving guete

Supplementary File "Pneumonia decision-making quotations by code.xlsx".

Decision and CDS opportunity timeline

The decision and CDS opportunity timeline revealed that decisions varied according to illness severity, and site of care decisions often occurred prior to diagnosis (see Supplemental Materials, Fig. 1).

Thematic analysis

Four themes were identified: i) ED decision-making for suspected pneumonia is a social process; ii) the "diagnosis drives treatment" paradigm is poorly suited to pneumonia decision-making in the ED; iii) The unpredictability of the ED requires deliberate and effortful information management by providers in CAP decision-making; and iv) the emotional stakes and high uncertainty of pneumonia care drive conservative decision making.

Theme 1. ED decision-making for suspected pneumonia is a social process

ED providers' treatment and disposition decisions reflected a range of social influences, often informal, from individuals within and outside of the ED. These influences included preferences of the admitting team, informal input from colleagues within the ED, and informal consultations with radiology and pharmacists. Of particular note, providers described eliciting the preferences of admitting physicians regarding antibiotic selection, ordering tests based on the perceived preferences of the admitting clinicians, and using severity indices as tools for "building a case" for admitting a patient with suspected pneumonia, as in the quotation below concerning the site of care decision:

The reason I like the [pneumonia severity index] score is, my main interaction with the patient, and my main question that I have with the patient in the emergency department is: do they need to be admitted or not? And then I have to defend the decision to admit the patient to a resident who is maybe overwhelmed... So you're familiar with Elisabeth Kübler-Ross and the stages of grief?... So my experience has been that if you tell a resident who is busy to admit a patient, and there's not a good reason for it, they're going to go through all five of those stages, right?... But if you tell them the patient has got a [pneumonia severity index] score of 90 or greater, they're going to go straight to acceptance.

- Emergency medicine physician from small facility with average hospitalization and high broad-spectrum antibiotic use (Interviewee 420137)

Another provider offered an example of ordering labs that they felt were unnecessary, but which were perceived by the ED provider as being important to the admitting team, as in this quotation about the decision to order blood cultures:

I've found [blood cultures] a lot of times to lead to a lot of complications that are unnecessary, but I still feel in our current environment that our inpatient people want blood cultures for pneumonia admission. And I have yet to have any of the inpatient people feel comfortable admitting somebody for pneumonia who doesn't have blood cultures... If I give antibiotics, and we haven't done blood cultures, I feel like the down-the-line complications and people getting upset can be pretty difficult.

- Emergency medicine physician from small facility with average hospitalization and high broad-spectrum antibiotic use (Interviewee 420138)

Providers described conflicts in diagnostic and patient disposition decisions between the feedback they received from radiology and the desires of admitting providers, with their desire to admit guided by an awareness of the uncertainty of the diagnosis and risk of complications based on contextual factors related to the patient that are not taken into account in guidelines, as in the quotation below.

I feel like I have a lot of people where the radiologist says they have pneumonia, and the admission team doesn't think so because the patient doesn't have a fever and doesn't have a white count. But a ton of

Table 1 Participating provider and facility characteristics

Individual characteristics

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Gender = male	13(81.25%)
Years since certification (mean, SD)	13 +/- 6.7
Physician (MD/DO)	14(88%)
EM specialty	10(62.5%)
Facility characteristics	
Small facility (complexity 2–3)	6(37.5%)
Hospital admission (overall)	$59 \pm 14\%$
Broad-spectrum antibiotic use	
Anti-MRSA antibiotics	$29 \pm 10\%$
Antipseudomonal antibiotics	$32 \pm 7\%$
Antibiotic use in lowest national quartile (< 25%)	6(38%)
Antibiotic use in highest national quartile (> 38%)	6(38%)
Hospitalization in lowest national quartile (< 50%)	3(18%)
Hospitalization in highest national quartile ($> = 70\%$)	4(25%)

our people are at huge risk for bad complications if they don't come in the hospital with pneumonia, and I find myself often at difficult medical decisionmaking on what to do with those people. I would say I more often than not err on offering admission to those people and often find that our medicine people want to send some of those people home, or not treat them for pneumonia.

- Emergency medicine physician from small facility with average hospitalization and high broad-spectrum antibiotic use (Interviewee 420138)

Theme 2: The "diagnosis drives treatment" paradigm is poorly suited to pneumonia decision-making in the ED

The normative expectation within the larger healthcare system that diagnosis should precede treatment conflicts with typical ED clinical practice, which prioritizes stabilization, followed by disposition and treatment decisions [62]. ED providers like this one were explicit that their primary role was to move patients rapidly to the most appropriate site of care:

We're here for life-threatening and surgical emergencies. That is what we're here for, and that is our one and only purpose. And some patients don't like it, but I think that's what my calling is as a board-certified emergency physician, is we try and keep people alive in a timeframe around their visit and decide who needs to be admitted and who can be treated as an outpatient.

- Emergency medicine physician from small facility with average hospitalization and high broad-spectrum antibiotic use (Interviewee 420138)

As a syndrome that both requires timely treatment and presents similarly to other common diagnoses, the uncertainty associated with CAP decision-making highlights the fact that treatment must often occur before clinicians arrive at a strongly supported diagnosis. Providers framed CAP diagnosis as an evolving, iterative evaluation of the patient's problem taking shape as other decisions (e.g. site of care or antibiotic selection) were made. Because ED provider time with a patient is limited and acuteness of a patient's condition may require rapid decision-making, some ED providers pushed back on the idea that they offered a diagnosis, preferring instead to characterize their working causal assumptions as clinical impressions. The quotation below offers an example of a provider rapidly coming to a clinical impression on presentation.

I felt pretty confident just on his initial presentation

of the [pneumonia diagnosis], yeah early on. But... of course I wanted to validate it with a chest x-ray... He was hypertensive and tachycardic and a bit tachypneic, as well. So obviously I was worried about sepsis... That was the thought process as well... I think I had already paged the [admitting provider] before I got the results of the x-ray just based on his clinical presentation.

- Advanced practice provider from large facility with low hospitalization and high broad-spectrum antibiotic use (Interviewee 420133)

Providers also reported rapidly initiating antibiotic treatment for CAP based on a wide range of factors, only some of which are directly described in CAP guidelines. These included perceived severity of suspected pneumonia, risk of complications and comorbidities, potential drug interactions and aspects of the patient's quality of life.

I had, I think in all three cases [of suspected pneumonia], I was suspicious enough to start antibiotics anyway before I got the chest CT. But so, blood cultures were done, antibiotics were given... In all three cases, they were on antibiotics before the CT, and they were getting fluids and drawing labs.

- Emergency medicine physician from large facility with low hospitalization and high broad-spectrum antibiotic use (Interviewee 420134)

Theme 3: The unpredictability of the ED requires deliberate and effortful information management by providers in CAP decision-making

The acuteness of patients' conditions and lack of information available to ED providers due to the ED being the first point of contact for patients meant that providers reported constantly seeking out and synthesizing information around them pertinent to their patients' suspected pneumonia. In the case below, the provider described integrating EHR and paper-based information on an ad hoc basis in their diagnostic decisions:

I would say I'm always in constant, you know, loops with the EHR especially after I order stuff like the ABG and lactate will come back pretty quickly, and I need to be aware of that. Although respiratory is, I would say 90% pretty good about physically handing you a paper but the other 10 to 20% you're just kind of waiting.

- Emergency medicine physician from large facility with high hospitalization and average broad-spec-

trum antibiotic use (Interviewee 420132)

Information management included physically moving between workstations and the bedside to check for updates on labs in the midst of caring for acute patients, as in the below case of simultaneous decision-making for site of care and diagnosis:

So I was sort of, at that point, saying I'm either going to push the pneumonia issue or I'm going to push a COPD exacerbation and I'll let the [procalcitonin] help me decide that. It hadn't come back yet so I told the nurse at some point I wanted him to stand up and walk around the unit a couple of times on a pulse ox and that happened somewhere between then and the time I got my [procalcitonin] back. And then when I had those two pieces of information I decided; one he needed to be admitted and, two, I was going to admit him as a pneumonia patient.

- Nurse practitioner from large facility with high hospitalization and average broad-spectrum antibiotic use (Interviewee 420142)

Beyond information search and synthesis, one provider described deliberately avoiding exposing themselves to information in the EHR in order to form a clinical impression with a lower risk of what they viewed as bias in their diagnostic decision-making.

I have a tendency, I never look at the labs or X-ray before I see the patient because that, sometimes it can give an anchoring place. Just go to the patient first, look from the history, and then I go to the labs. Even if I have the labs, I don't look at it.

- Internal medicine physician from large facility with high hospitalization and high broad-spectrum antibiotic use (Interviewee 420129)

Clinicians described integrating technologies like the EHR, patient and family reports, and nursing updates into a constantly changing mental model of the event. Their comments suggest that small modifications to the physical setting of care may change how information is accessedand increase cognitive load. For example, one provider recounted providing care for suspected pneumonia in an unfamiliar room in the ED where they did not have access to the EHR, and thus needed to take extra precautions with medication orders.

I think the initial time pressure was waiting for respiratory to come down for the intubation and then, getting everything in the room... Because I'm not at the computer, so I'm verbally telling them I need etomidate and [succinylcholine] and, you know, triplechecking those doses to make sure the patient's getting appropriate dose since the nurse doesn't have an order from me.

- Emergency medicine physician from large facility with high hospitalization and average broad-spectrum antibiotic use (Interviewee 420132)

Theme 4: The emotional stakes and high uncertainty of pneumonia care drive conservative decision making

The high stakes, time pressure and uncertainty of care in the ED mean that provider decision-making processes reflect the anticipation of potential decisional regret for care decisions with serious consequences. The role of uncertainty about how suspected pneumonia would interact with a patient's life factored particularly clearly in the site of care decision, which was the providers' first priority after stabilizing the patient, as seen in the quotation below.

I'm from [rural state], and so a lot of times when I admit a class three pneumonia, it's psychosocial, because I know that the [rural county] paramedics that would bring my patient back in in the [city] area are way different from some guy who is living in a trailer with no electricity in [rural town]. He's not going to have the ability to come back in that somebody down here would... When I get [clinicians] who don't attach as much importance to that as I do, it's a challenge for me, and I try to communicate it... I think a lot of people think of rural means you live in a small town. It doesn't necessarily mean that you live in a trailer at the end of a road that doesn't get plowed.

- Emergency medicine physician from small facility with average hospitalization and high broad-spectrum antibiotic use (Interviewee 420137)

An admission such as the one described above could appear "low risk" if considered outside of the context described by the interviewee. Concerns such as those articulated above clarify that uncertainty about diagnosis and potential complications were emotionally charged. Beyond site of care, conservative decision-making could extend to the ordering of additional labs, such as requests for CT imaging when x-rays left providers still uncertain about the clinical problem, as in the quotation below.

I talked to the radiologist before I ordered the CT asking if that was a reasonable thing to do... I talk with her a lot on cases. And she thought it was quite reasonable.

- Emergency medicine physician from large facility with low hospitalization and high antibiotic broadspectrum antibiotic use (Interviewee 420134)

Providers emphasized that they received little formal feedback except in the case of serious unexpected negative clinical outcomes.

I get minimal feedback... My sense is that if [I] was doing things wrong I would hear about that... I think [my chief] trusts me, believes in me. But it's never like a formal sit-down meeting or anything if that's what you mean... Sometimes I'll hear from the doctors down the road, [name], "You really got it right". And then sometimes I'll look at the records and it's like, oh, you know, they do some tests that makes the diagnosis that I missed... Otherwise, the only way you really get feedback [is] if something has gone really wrong and a patient ends up getting—or a case ends up getting referred for some kind of peer review.

- Emergency medicine physician from large facility with high hospitalization and average broad-spectrum antibiotic use (Interviewee 420141)

Discussion

This study conducted semi-structured qualitative interviews with 16 VA providers to understand drivers of variation in decision making processes for patients with suspected pneumonia in the ED. Our overall findings highlight the importance of social influences on provider decision-making, and the pervasive impact of diagnostic uncertainty on treatment and site of care decisions, aspects of clinical decision-making that are infrequently considered in the context of clinical decision support [1] and likely contributors to practice variation [43, 50, 52, 63]. In relation to our first theme, we found that decision-making for suspected pneumonia is intrinsically social insofar as it reflects influences on an ED provider's decisions from others both inside and outside the ED. In this respect, pneumonia decision-making embodies local cultures of clinical practice in much the way that antibiotic use and stewardship have been shown to be conditioned by local norms and relationships between clinicians, stewards and pharmacists [64-69]. This finding also bears similarities to existing work on organizational sense-making (i.e. the establishment of socially shared understandings of the world [70-72] in the emergency department and elsewhere [73-76], particularly on provider communication and the redistribution of responsibility and accountability in patient handoffs and ED admissions [77-80]. It also may help us to understand geographic variation in practice, as providers may behave similarly to colleagues within a local context, but quite differently from other contexts.

Second, in contrast with the "diagnosis-drives-treatment" paradigm encouraged by the Institute of Medicine (IOM) [81], treatment often precedes diagnosis in the ED. This divergence from the IOM model reflects numerous competing priorities faced by ED providers, including: 1) diagnostic uncertainty (i.e. because the ED is the first point of contact with the healthcare system for patients with emergent health problems, it is the setting with the least information about the underlying cause of a patient's presentation); 2) the acute, time-sensitive nature of patients' conditions (which may require immediate stabilization before any other clinical process); and 3) the use of time- and productivity-based quality metrics to evaluate ED performance, which orient providers' attention to the timeliness of patient movement through the ED. ED deviation in CAP care from the IOM paradigm [81] resembles processes documented in the context of sepsis [82, 83], which occurs in many patients with pneumonia. Providers' references to the uniqueness of ED practice accord with current debates that have emerged around diagnostic error in the ED, and suggest the need to carefully consider the ED's unique characteristics when interpreting ED provider use of diagnostic codes [84].

Third, we found that the unpredictable nature of ED work impacted how clinicians approached CAP decision making. One consequence of this is that pneumonia diagnosis in the ED is subject to a high degree of uncertainty and unpredictability, not only in the patient's diagnosis and outcomes, but also in the provider's workflow and information sources, timing, availability, and needs. The ability to clearly synthesize the information driving diagnostic decisions and to convey uncertainty to admitting teams may both be important considerations in the design of future tools for pneumonia care. Diagnostic uncertainty may be masked or hidden from view where the assignment of a diagnosis is prematurely "forced" by CDS or the EHR (e.g. when it is a required input to enact healthcare transactions such as patient handoffs or treatment orders).

Finally, we found that care fragmentation, lack of mechanisms for follow-up and non-clinical factors that increase uncertainty around patient outcomes (e.g. a patient's functional status or social determinants of health) all placed additional emotional burden on ED providers. Admission decisions were informed not only by a patient's clinical status, but by the risk the patient would face if their condition worsened, if treatment proved ineffective, or if the provider's diagnosis was incorrect. The lack of any convenient mechanism for ED providers to learn about a patient's ultimate diagnosis or outcome seemed to factor into providers' assessments of the risks of sending patients home, leading to conservative decision-making in some cases. This resonates with existing research detailing a wide range of "nonclinical" patient and contextual considerations in ED decision-making [85–87] The emotional burden of decision-making under uncertainty and fragmentation could help explain the practice of low-risk hospitalizations and broad-spectrum antibiotics, both of which have previously been identified as targets for implementation [88]. When attempting to understand "low-value" care conducted by ED physicians, it is important to consider this emotional element of their clinical experience.

We note that the themes identified by this study do not have a one-to-one relationship with conventional categories of clinical decision-making (site of care, diagnosis, treatment). Instead, they crosscut all of these decisions, impacting them in different ways depending on context. This is further evidenced by the fact that many examples of pneumonia care given by providers referenced multiple decision types simultaneously (please see the worksheets in Supplemental Materials labeled Themes 1–4). This insight from the study suggests the value of approaches that study clinical decision-making holistically and in context.

Our findings also suggest some ways that CDS should be designed so that it better reflects the social nature of ED decision-making; the ubiquity of uncertainty in ED diagnostic reasoning; the numerous structural constraints on ED care; and individual patient factors such as social determinants of health that influence decision-making. First, since most CPGs require a diagnosis, clinical pathways based narrowly on CPGs for specific conditions run the risk of poorly fitting patients for whom there is substantial diagnostic uncertainty. Given that many diagnoses are uncertain, syndromebased decision support that encourages providers to continuously consider alternative diagnoses would be a better fit than disease-based pathways. While the communication of uncertainty to patients is a long-running theme in research on the ED [89-92], research on the acknowledgement and management of uncertainty between clinicians is more limited [93-96]. Accommodating diagnostic uncertainty in CDS may be especially important in the ED, given its nature as a frequent first point of contact for patients with the healthcare system. Some prior work has noted the importance placed by providers on social input when dealing with clinical cases with high uncertainty [95]. Tools designed to explicitly acknowledge or document diagnostic uncertainty are not widely reported in the literature. Welldesigned tools that acknowledge diagnostic uncertainty in the ED might bring clarity to current debates about the nature of ED diagnosis and the interpretation of measures of ED diagnostic accuracy [82, 83]. Lack of feedback on diagnostic performance presents another important opportunity for CDS [84]. When considering the role of CDS in mitigating "low-value" care such as antibiotic overuse [43] or low-risk hospitalizations [32], tools that support diagnostic uncertainty but also track patient status across the hospital stay or after discharge might enable learning and reduce risk-averse decisionmaking around antibiotic selection and site of care, in keeping with the model of a learning health system [43].

Second, the social interactions that our interviewees reported (both with other clinicians and with patients) involved information gathering and synthesis, but also consensus-building or affirmation-seeking about diagnostic, treatment and site-of-care decisions. Locally validated and trusted standardized assessments such as the pneumonia severity index can help to build a sense of shared responsibility or accountability for clinical decisions and outcomes, a complex problem in ED workflows [97-99]. While public display tools such as electronic whiteboards have most often been studied to understand their impact on ED efficiency [89, 100, 101], they could also potentially play a role in stimulating explicit reasoning, dialog and consensus-building about patient care plans as well as identifying patient factors beyond illness severity that warrant conservative care plans [43]. Other types of EHR-embedded CDS may be important for documenting diagnostic uncertainty, a feature of clinical decision-making that providers may feel uncomfortable explicitly stating. The social dynamics of clinician interpersonal consultation, dialog and consensus building are likely to be highly specific to clinics and care teams. CDS that embeds open-ended functionality supporting these activities may prove to be more responsive to the needs of local contexts, and thus more scalable, than strictly CPG-based CDS tools, which often exhibit low rates of acceptance when they are scaled beyond the settings in which they are designed [7, 43, 44].

In sum, our findings advance our understanding of decision-making for pneumonia in the ED, explain sources of variation in practice, and inform future design of CDS. CDS tools for CAP in the ED are likely to be most successful when they: 1) acknowledge and explicitly capture degrees of uncertainty in diagnoses or clinical impressions; 2) support the consideration and work-up of alternative diagnoses; 3) help ED providers track patients' statuses across their hospital stays and/or their status after discharge; 4) allow documentation of, and search for salient aspects of a patient's living situation and social determinants of health; and 5) support the social interactions inherent to real-world clinical decision-making by

providing socially accepted standardized assessments and other ways to support, document and publicize collective reasoning, decision-making and consensus-building.

Study limitations

This was a qualitative study that used a purposive sample of diverse healthcare facilities to explore variation in decision-making for pneumonia among ED providers in the VA. The VA differs from other healthcare systems, as its ED is often staffed with non-emergency medicinetrained providers, and it serves a population that is older and more complex than the general population. Exclusive use of VA providers may also impact generalizability of results beyond the VA due to idiosyncrasies of the VA healthcare system and its workflows. For these reasons, study results may not be representative of all EDs. Interviews were conducted before the COVID pandemic, which may have changed provider decision-making around respiratory disease. Finally, the study relied on self-reports of clinical practices elicited via cognitive task interviews, which may be prone to biases, for example related to providers' recall and selection of clinical cases.

Conclusion

This study highlights underappreciated dynamics of ED decision-making for complex syndromes like pneumonia, with implications for future CDS aimed at scaling across healthcare systems for diverse populations. CDS for pneumonia that presumes that decisions are made independently by individual, wholly autonomous providers exclusively analyzing patient signs, symptoms and lab results to make clear, singular diagnosis, and proceeding in lockstep fashion from diagnosis to treatment in isolation from the workflow of the ED, would poorly reflect empirical reality. Ensuring that CDS reflects the realities of clinical work as a socially organized process with high uncertainty may ultimately improve communication between ED and admitting providers, continuity of care and patient outcomes.

Supplementary Information

The online version contains supplementary material available at https://doi. org/10.1186/s12911-024-02805-8.

Supplementary Material 1. "Pneumonia decision-making supplemental materials 112124.xlsx" provides a subset of de-identified qualitative study data organized by code; additional supporting quotations for each of the four themes; and a figure illustrating a timeline for pneumonia decision-making derived from the study's interview data.

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Authors' contributions

PT: Data curation, formal analysis, methodology, writing – original draft, writing – review & editing. CW: Formal analysis, methodology, writing – review & editing. SLZ: Methodology, writing – review & editing. ER: Validation, writing – review & editing. JB: Methodology, writing – review & editing. BEJ: Conceptualization, formal analysis, funding acquisition, investigation project administration, resources, supervision, writing – original draft, writing – review & editing.

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Data availability

The file "Pneumonia decision-making supplemental materials 112124.xlsx" provides a subset of de-identified qualitative study data organized by code; additional supporting quotations for each of the four themes; and a figure illustrating a timeline for pneumonia decision-making derived from the study's interview data.

Declarations

Ethics approval and consent to participate

The study was deemed exempt after review by the University of Utah and VA Salt Lake City Institutional Review Boards (IRB_00065268). Verbal informed consent to participate was obtained from all interviewees.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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