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LEDER

REDAKTIONENS FORORD

Af redaktionen: Christian Skjærbæk, Gitte Boier Tygesen, Iben Duvald Pedersen, Helene Skjøl-
Arkil, Peter Biesenbach, Masoud Moradi, Martin Hagi

Beredskabshændelser betegner ekstraordinære situationer, der ikke kan håndteres ved hjælp af almindelige rutiner og ressourcer. I hospitals-sammenhæng tænkes ofte på storulykker med mange tilskadekomne. Centralt i planer for at håndtere beredskabshændelser på et hospital er muligheden for at kunne tilkalde ekstra personale udover det personale, der allerede er på arbejde på det givne tidspunkt.

Truslerne mod vores samfund og sundhedsvæsen er imidlertid mangeartede, og nogle nye trusler synes at trænge sig på, med voksende risiko for at udløse beredskabshændelser. Det kunne være store forureninger, giftulykker, naturkatastrofer eller voldsomt vejr, samt spredning af smitsomme sygdomme uden for det normale forekomstområde, hjulpet på vej af både voksende rejseaktivitet og klimaforandringer. Muligheden for terror, voldelige konflikter eller egentlig krig er også hændelser, man er nødt til at tage højde for. Fælles for mange af disse ”nye” trusler er, at de også kan udgøre en risiko for sundhedspersonalet i det øjeblik, de indtræder. Det er en åbenlys sårbarhed i en beredskabsplan, hvis det personale, der skal træde til, undviger derfra i utryghed om egen sikkerhed.

Tidsskriftet bringer i denne sommerudgave en artikel af Gerhard Tiwald og Yohan Robinson, der har spurgt sundhedspersonalet i to danske akutafdelinger om deres vilighed til at møde op under forskellige tænkte beredskabsscenarier, og hvilke forhold, der kunne påvirke denne. Emnet er åbenlyst vigtigt og bør medtænkes i lokale beredskabsplaner.

Tidsskriftet bringer denne gang en faglig leder: ”At tælle eller ikke at tælle – det er spørgsmålet om B-linjer” af Michael Dan Arvig, der opfordrer til et opgør med dogmet om, at interstitielt syndrom er en diagnose man kan tælle sig frem til ved hjælp fokuseret ultralyd af lunger.

En faglig leder er forfatterens personlige faglige tilkendegivelser om et emne, der falder inden for tidsskriftets emneområde. Faglige ledere undergår ikke traditionel fagfællebedømmelse, men vurderes og godkendes af redaktionen. Indholdet udtrykker ikke nødvendigvis redaktionens holdninger. Faglige ledere kan være inviteret af redaktionen, men vi modtager også meget gerne uopfordrede bidrag om faglige emner, der bør rejses til debat.

I lighed med tidligere år, har vi til denne sommerudgave inviteret ph.d.-kandidater fra det seneste år til at lade Tidsskriftet bringe et resume af deres ph.d.-afhandling. Forskning i det akutmedicinske felt er i vækst, specialet modnes, tværfagligheden dominerer og det aflæses også i antallet af ph.d.er. Vi er klar over, at vi ikke denne gang har fået alle med, men modtager gerne resuméer til publikation også i den næste udgave i december 2026.

I dette nummer finder I også en kasuistik af Karen Bjerum og kolleger. Den beskriver et tilfælde af Mycoplasma pneumoniae-induced Rash and Mucositis (MIRM) som følge af infektion med Mycoplasma pneumoniae hos en ung mand. Det er en sjælden følgetilstand, som indebærer risiko for ikke at blive genkendt i en akutafdeling. Som det beskrives af forfatterne, kan tidlig erkendelse af MIRM og tidlig opstart af behandling og opfølgning være vigtig for at mindske risikoen for komplikationer og varige mén for patienten.

I en anden kasuistik af Michael Dan Arvig beskrives et tilfælde af det sjældne men alvorlige Lemierres syndrom hos en patient med forudgående halssymptomer. Kasuistikken lærer os, at Lemierres syndrom også kan forekomme uden trombe i halsvener og i det tilfælde beror diagnosen i stedet på dyrkningsfund af *Fusobacterium necrophorum*.

Endelig bringer vi en protokolartikel af Uswa Nissar Anjum og kolleger. Artiklen beskriver et planlagt review fra forfatterne, der har til formål at give en oversigt over AI-baserede triagemodeller og kortlægge eventuelle mangler i design, den kliniske effektivitet og implementering i akutafdelinger. Projektet forventes at kunne bidrage til udvikling af endnu mere effektive AI-modeller til gavn for patientbehandling og driften i akutafdelinger.

Den aktuelle sommerudgave favner således en stor del af de artikeltyper, vi bringer i Dansk Tidsskrift for Akutme-

dicin: originalartikler, kasuistikker, resuméer af afhandlinger, protokolartikler og faglige ledere. Øvrige artikeltyper er statusartikler, danske resuméer af originalartikler og kliniske retningslinjer, som vi også gerne modtager bidrag til. Se mere på [Indsendelser | Dansk Tidsskrift for Akutmedicin](#).

Vi håber under alle omstændigheder, at I vil læse med og lade jer inspirere.

Redaktionen ønsker alle forfattere, bedømmere og læsere en god sommer!

Dansk Tidsskrift for Akutmedicin

Juli 2026

LEDER / EDITORIAL

OPEN ACCESS At tælle eller ikke at tælle – det er spørgsmålet om B-linjer
En nekrolog om interstitielt syndromMichael Dan Arvig  ^{1,2,3*}

¹Research Entity for Studies in Clinical Acute Medicine (RESCUE), Akutafdelingen, Midt- og Vestsjællands Hospital, Ingemannsvej 50, Slagelse, Danmark. ²Institut for Klinisk Medicin, Københavns Universitet, Blegdamsvej 3B, København, Danmark. ³Institut for Regional Sundhedsforskning, Syddansk Universitet, J.B. Winsløvs Vej 19, Odense, Danmark.

Korrespondance (*): doktorarvig@gmail.com

Om fagligere ledere: Faglige ledere undergår ikke traditionel fagfællebedømmelse, men vurderes og godkendes direkte af redaktionen. Indholdet og holdningerne i artiklen udtrykker forfatterens egne synspunkter og repræsenterer ikke nødvendigvis redaktionens officielle holdning.

Fokuseret lungeultral lyd (FLUS) er et centralt redskab for akutlægen. Med FLUS kan man hurtigt afklare, om patienten har tegn på nogle af de væsentligste hjerte- og lungetilstande, vi ser i akutafdelingerne: pneumoni, pleuraeffusion, pneumothorax og vand i lungerne.

FLUS er en point-of-care-undersøgelse, hvilket refererer til, at den foretages dér, hvor patienten befinder sig, men lige så vigtigt, at den fortolkes i realtid og sammen med anamnese og de øvrige kliniske fund. Den kan således stort set aldrig stå alene og slet ikke, når det drejer sig om B-linjer. FLUS er også fokuseret. Det betyder, at man besvarer en række spørgsmål om, hvorvidt der er tegn på, at en bestemt tilstand er til stede eller ej. Disse spørgsmål er udvalgt for de områder, hvor 1) tilstanden er relativt hyppig i akutafdelingen, 2) evidensen er tilstrækkelig til, at tilstanden kan be- eller afkræftes med rimelig sikkerhed, samt 3) svaret på spørgsmålet er relevant for det akutte forløb.

I mange år er det blevet doceret (herunder af undertegnede), at et af disse spørgsmål er, om der er tegn på interstitielt syndrom [1]. Dette sindrige og ikke særlig operationelle syndrom blev defineret under en international konference i 2012 som den mundrette størrelse af ≥ 3 B-linjer i ≥ 2 zoner på begge lunger [2]. Definitionen byggede på studier, pragmatisme og konsensus. Syndromet bruges desværre ofte som en utvetydig sandhed, men indeholder også en indbygget komisk tvetydighed. Definitionen er kvantitativ og bygger på antagelsen om, at B-linjer kan tælles, som fx at tælle antallet af publikummer til Trumps indsættelsesceremoni. Men vi ved også, at B-linjer er meget afhængige af de tekniske indstillinger, fx gain, dybde og frekvens, ligesom de er operatøraftængige, fx i vurderingen af, om det er en reel B-linje eller ej, vinkling af proben og mængden af koffein i blodet (hos lægen) [3].

Principielt kan to forskellige læger skanne den samme patient inden for kort tid, hvor den ene læge mener, at syndromet er til stede, mens den anden ikke mener det. B-linjer er således en semikvantitativ variabel i spektret mellem objektivitet og subjektivitet, hvilket gør det

endnu mere absurd at have et spørgsmål baseret på at tælle noget helt ned til en præcis størrelse, men som reelt ikke kan tælles nøjagtigt.

Derudover ved vi fra flere studier, især af hjertesvigtspatienter, at B-linjer er dynamiske og ændrer sig over kort tid [4]. Vand i lungerne er ikke en dikotom størrelse. Det er et kontinuum, hvor patienten gradvist ophober mere og mere væske fra lungestase til fulminant lungeødem, og hvor der kommer flere og flere B-linjer. I et studie, hvor man sammenlignede lungeultralyd med CT af lungerne, der er noget mere diagnostisk præcis, fandt man, at i en 8-zoners skanningsprotokol kan helt ned til (cirka) syv B-linjer i alt - og uanset fordeling - betyde, at der er vand på lungerne [5]. Herudover viste studiet, at man også bør inddrage, om der er pleuraeffusion, i sin fortolkning af, om der er vand på lungerne.

Derfor er det på tide at gentænke det fokuserede spørgsmål. Spørgsmålet bør være mere simpelt: Er der tegn på B-linjer - ja/nej. Vurder B-linjerne helt overordnet frem for at stå bøjet over skanneren og tælle: Var der to eller tre i den zone? Kig på deres fordeling i stedet: Er de på begge lunger? I flere zoner? Er der få/mange i hver zone?

Så at tælle eller ikke at tælle er måske spørgsmålet. Men svaret findes ikke i, om du kan tælles til $3 \times 2 \times 2$, men i den kliniske kontekst!

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ORIGINAL-, UDVIKLINGS- OG KVALITETS-
ARTIKLER
ORIGINAL ARTICLES



ORIGINAL ARTICLE

OPEN ACCESS

Willingness to Work during Mass Casualty Incidents among Emergency Department Healthcare Workers in the Zealand Region, Denmark

Gerhard Tiwald^{1*}  | Yohan Robinson² ¹Zealand University Hospital, Køge & Roskilde, Denmark. ²University of Gothenburg, Gothenburg, Sweden.Correspondence (*): gti@regionsjaelland.dk

Abstract

Background: Mass casualty incidents (MCI) cause a surge in healthcare needs, requiring additional staff and the activation of disaster plans. A key question is whether healthcare workers (HCWs) are willing to respond to the call and come to work.

Aim: This study evaluates the willingness of HCWs in the Zealand region, Denmark to work during MCIs, exploring influencing factors and conditions in comparison to previously published studies.

Methods: A cross-sectional, survey was conducted in two emergency departments across three hospitals in Zealand, Denmark. Data collection utilized an online questionnaire based on the "Fight or Flight" questionnaire developed by the University of Leuven, Belgium.

Results: Out of 508 invited HCWs (nurses, doctors, and secretaries), 103 fully answered the questionnaire (response rate 20.3%). Among them, willingness to work (WTW) unconditionally was highest for influenza pandemics (68%), SARS/COVID-19 (63%), and mass shootings (53%). The lowest WTW occurred during nuclear incidents (28%) and dirty bombs (29%). Key conditions for WTW included family safety (84%) and personal protective equipment (79%). Doctors showed higher WTW than nurses, and prior disaster training significantly influenced WTW for specific scenarios ($p < 0.05$).

Conclusion: High WTW rates suggest a self-evaluated readiness among Danish HCWs in the Zealand Region, especially during pandemics. However, WTW was lower for some scenarios, such as nuclear and radiological events. We suggest, based on the results, that targeted training could enhance preparedness and WTW.

Keywords: Disaster response; Mass casualty incident; Willingness to work; Healthcare workers; Emergency department; Fight or flight

Introduction

In 2023, a total number of 399 natural disasters like earthquakes, storms and heat waves were reported worldwide, leading to over 86,000 deaths and affecting 93 million people, and the numbers are increasing (1). These events, as well as pandemics and larger accidents, would cause a surge in healthcare needs and can overwhelm the capacity of a healthcare system. Almost all hospitals worldwide have recently had to adjust to the COVID-19 pandemic, and infectious diseases remain a high-ranking threat to healthcare systems (2). Furthermore, a severe dysfunction or breakdown of essential supplies and infrastructure (e.g. water, power, sanitation, communication, digital healthcare records) affects a hospital's ability to provide its services at a normal level (3). These hazards are also identified for Denmark (4). All hospitals in Denmark are obligated to prepare for mass casualty incidents (MCIs) under national guidelines (5). MCIs are defined as an overwhelming demand for healthcare needs, that cannot be met by normal day-to-day resources (6).

The healthcare sector is suffering from a shortage of qualified staff, especially nurses also in Denmark (7). With regard to the emergency department, a major question is if all healthcare workers (HCW) will respond to the activation of the MCI plan and come to work, as activating off-duty personnel and staffing up is a key component of this activation. This positive attitude to help outside one's normal working schedule and in scenarios which include a certain risk to health and safety defines "willingness to work" in this study. Without qualified HCW available, preventable deaths can occur.

No such survey has so far been conducted in Denmark. This study was conducted as part of the European Master in Disaster Medicine (EMDM) program, an international advanced Master of Science program organized by CRIMEDIM, University of Eastern Piemonte, Italy, and REGEDIM, Free University of Brussels, Belgium, for the purpose of teaching and supporting state-of-the-art and evidence-based knowledge about disaster medicine (8).

The aim of this study is to evaluate the willingness of HCWs in two emergency departments in the Zealand region, Denmark, to work during MCIs, exploring influencing factors and conditions.

Methods

STUDY DESIGN

The study used a survey to generate a numeric representation of specific scenarios. The original survey was developed by the Center for Research and Education in Emergency Care (CREEC) of the University of Leuven, Belgium (9). The English version (10) was translated to Danish by the author by performing a back-and-forth translation using Google Translate (11).

After face-validation the questionnaire's content validity was reviewed by a panel consisting of two nurses and one specialist doctor in emergency medicine, who represented the target groups. All three participants of the panel were native speakers of Danish, working at the same department as the author and were involved in the disaster training in the department. They were given the opportunity to rephrase the questionnaire when there were doubts about the validity and understandability of the translation from a cultural perspective. For conditions necessary to come to work, one or more answers were possible. Individual knowledge of the scenario was covered by a question regarding previous training. The responses to the questionnaire were voluntary and anonymous. By participating in the questionnaire, the participants consented to the use of the submitted data.

FIGHT OR FLIGHT-QUESTIONNAIRE

The fight or flight-questionnaire (9) has been used in several previous studies from Norway (12), Saudi Arabia (10), Belgium (9, 13) and the Netherlands (14). The healthcare systems in Norway, Belgium and the Netherlands are generally considered comparable to the Danish healthcare system (15, 16). The healthcare system of Saudi Arabia consists of a larger private sector, and the workforce is to a considerable extent recruited from abroad (17). Despite these differences, the results for

WTW in the previous studies were consistent regarding different WTW for doctors and nurses, female vs. male.

DATA COLLECTION

The “Survey Xact” internet-based platform (Xact by Ramboll, DK-8200 Aarhus) was used to collect data. All data were stored on an encrypted and password-protected server of the Zealand region. A link to the electronic questionnaire was distributed via e-mail to all 508 employees of two emergency departments (ED) of Zealand University Hospital, covering the hospitals at Roskilde, Køge and Nykøbing Falster on November 1st, 2024.

The distribution was facilitated by the leadership of the two departments, who sent the link and information about the study in a weekly newsletter. Nurses, medical doctors and secretaries were included, medical students, nursing students and other professions were excluded and not invited to answer the questionnaire. Only employees with contractual relations to the departments were included. One week after the initial distribution of the link, a reminder was distributed, after another week a personal invitation was sent to the work email of the employees by the heads of the department. The data-collection was terminated by December 1st. No time limit was predefined to complete the questionnaire. The two departments were chosen, as they represent an urban academic hospital (at the sites in Køge and Roskilde) and a rural ED in Nykøbing Falster. As both departments are organized under Zealand University Hospital and located within the same healthcare-region, sampling bias is possible.

The questionnaire used is included in Appendix 1.

ETHICAL CONSIDERATIONS

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was not required under Danish legislation, as the study involved voluntary participation in an anonymous survey without the collection of sensitive personal data or medical information (18). All data were collected and stored securely using a password-protected online

platform. No personally identifiable information was collected, ensuring complete anonymity. Data processing complied with General Data Protection Regulation (GDPR, EU 2016/679) standards to protect privacy and confidentiality.

Participants were informed that the participation in the questionnaire was voluntary and that they consented by actively following the link and completing the survey. As the data were collected anonymously, a later withdrawal of consent was not possible.

STATISTICS

Cronbach's alpha was calculated (19), and Fisher's exact test (p-value) was performed (20), using SPSS (IBM). Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. It is considered to be a measure of scale reliability. Fisher's exact test is a statistical hypothesis test used to assess the association between two binary variables in a contingency table and is particularly useful when working with small-sized samples. Data presented with mean and standard deviation were calculated with Microsoft Excel. Human Resources provided the information that a total of 508 HCWs are employed in the two emergency departments of choice. The sample size was set at 250 healthcare practitioners based on a power calculation (Raosoft Inc., USA) (21), assuming 4.5% precision with 50% prevalence and a population size of 508 with a 95% confidence interval and specified limits. As only fully completed questionnaires were analysed, there were no missing data.

Results

A total of 103 fully answered questionnaires were collected and further processed. 12 incomplete questionnaires were excluded from further analysis. The percentage of fully answered questionnaires was 20.3%. Demographics are shown in Table 1. It shows that most of the respondents were female (N=78). 34 of the responders were doctors, 54 nurses, and 15 were secretaries (others). Of the 34 doctors, 22 were junior doctors, and 12 consultants. Nine of the responders had leadership roles, and 10

were without patient contact (with overlap of these groups). 75 of the responders were living with a partner, 74 had children, and 44 had children in the same home.

Table 1. Summary of demographics of included study participants, totals and percent, w/o: without.

	Total = 103	%		%
Profession	34 doctors in total	33.01		
	22 junior doctors/residents	21.36		
	12 consultants	11.65		
	54 nurses	52.43		
	15 others	14.56		
Gender	78 female	75.73	25 male	24.27
Leadership role	94 employees	91.26	9 managers	8.74
Patient contact	93 regular	90.29	10 w/o	9.71
Partner	75 living with partner	72.82	28 w/o	27.18
Children	74 with children	71.84	29 w/o	28.16
Children at home	44 with children at home	42.72	59 w/o	57.28

Regarding their WTW, four categories could be chosen from in relation to 12 different scenarios. The Cronbach's Alpha for the WTW-questions was 0.915, which indicates a very high reliability of consistency.

The categories "Yes unconditionally" and "Yes under certain conditions" were considered positive/high, while "probably not" and "certainly not" were considered negative/low in the further analysis, where they were not referred to individually.

Conditions to come to work were only obtained from the responders who answered "Yes, under certain conditions" (N=29-61, see Figure 1). The result of the individual conditions is shown as sum in Figure 2 for all scenarios. That was considered useful and necessary due to the small numbers but can influence the generalizability of the results for some conditions, e.g., PPE and vaccination for scenarios without an infection hazard.

The scenarios with the highest rates for WTW unconditionally or under certain conditions were influenza, pandemic with special influence like bird flu, SARS/COVID-19 and mass shooting. The lowest WTW was observed for nuclear incidents and dirty bombs. In these scenarios, as well as in natural disasters, bomb threats and mass shootings, the majority would attend under certain conditions. The rate of not attending work or having serious doubts was generally very low. See Figure 1.

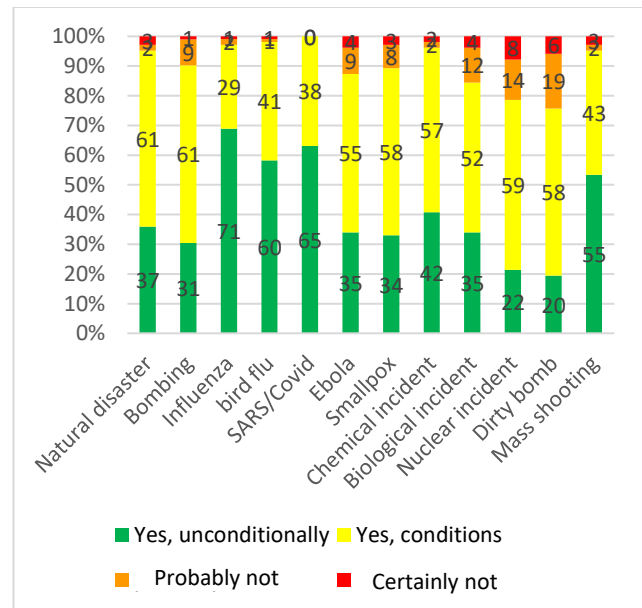


Figure 1. WTW in percent for all responders (Y-axis: colours). Number in column: totals of individuals = (n).

Doctors showed a higher WTW unconditionally than nurses, males higher than females, HCWs without a partner, children or children at home higher than HCWs with a partner, children or children at home. In some scenarios we did find a significant p-value despite the overall low numbers. The following combinations showed significant influence: Profession (doctors with a higher WTW than nurses) for Ebola-outbreak, chemical incident, biological incident and dirty bomb; Gender (male with higher WTW than female) for natural disaster, bomb threat, chemical incident, nuclear incident, and dirty bomb. Responders living with a partner were less likely to respond unconditionally to influenza, bird flu, Ebola, biological incidences, and shootings. Responders with children were less likely to respond unconditionally to natural disasters, influenza-pandemic, bird-

flu, chemical incidences and biological incidences. Children at home had a significant influence on the response to natural disaster, bomb threat, Ebola, chemical incidents and mass shooting. For p -values see Table 2.

	Natural d.	Bombing	Influenza	Bird flu	SARS	Ebola	Smallpox	Chem. Inc.	Bio. Inc.	Nuc.inc.	Dirty bomb	Shooting
Profession (doctors higher rate of WTW unconditionally)	n.s.	n.s.	n.s.	n.s.	n.s.	0.002	n.s.	0.019	<0.001	n.s.	0.028	n.s.
Gender(male higher rate of WTW u.)	0.018	0.019	n.s.	n.s.	n.s.	n.s.	n.s.	0.016	n.s.	<0.01	0.019	n.s.
With partner lower rate of WTW u.	n.s.	n.s.	0.02	0.011	n.s.	0.044	n.s.	n.s.	0.032	n.s.	n.s.	0.019
With children lower rate of WTW u.	0,03	n.s.	0.045	0.021	n.s.	n.s.	n.s.	0.004	0.018	n.s.	n.s.	n.s.
With children at home lower rate of WTW u.	<0.001	<0.001	n.s.	n.s.	n.s.	0.006	n.s.	0.001	n.s.	n.s.	n.s.	0.002
Training in disaster managment												
Higher rate of WTW u.	0.023	n.s.	n.s.	n.s.	n.s.	n.s.	0.019	n.s.	n.s.	9	n.s.	n.s.
Training in epidemics	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Training in chem. inc.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Training in nuclear inc.												
Higher rate of WTW u.	0.046	n.s.	n.s.	n.s.	n.s.	0.034	0,04	n.s.	n.s.	0.004	0.016	n.s.
Training in mass casualty												
Higher rate of WTW u.	n.s.	0.018	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table 2. The influence of demographics and previous training on WTW in different scenarios. p -values (yellow when $p < 0.05$ and red when $p < 0.01$) for demographics and training-status regarding the different scenarios. d: disaster, Chem.Inc.: chemical incident, Bio.Inc.: biological incident, Nuc.inc.: nuclear incident, n.s.: not significant ($p \geq 0.05$), u: unconditionally.

Previous training had a significant influence on the WTW in some scenarios.

Training in disaster management had a significant positive influence on the WTW in natural disaster, smallpox and nuclear incidences. Training in epidemics and chemical incidences had no significant influence. Mass casualty training had an influence on bomb threats, whereas responders trained in nuclear incidences had higher WTW unconditionally in natural disasters, Ebola, smallpox, nuclear incidents and dirty bombs. See also Table 2.

Asked about conditions to attend work, the responders could choose between 10 different conditions. The most important condition was identified as safety for their family, followed by availability of personal protective equipment (PPE), proper education and training, the possibility for contact with their family and a high level of information about the development of the MCI situation. All other conditions, such as extra salary, free antidots, vaccines only seemed to play a minor role. See Figure 2.

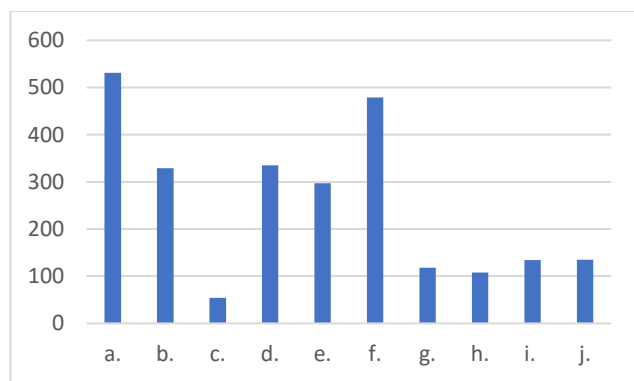


Figure 2. Conditions for coming to work, as sum for conditions from all scenarios. a. if my family is safe and taken care of, b. if I can be sure to come in contact with my family, c. if my boss is coming to work too, d. if I get sufficient training, e. if I get updates about the development, f. if necessary PPE is provided, g. if I get extra salary, h. if I get antiviral drugs for free, i. if free antidote is provided, j. if free vaccines are provided. Shown as sum of all 12 scenarios where “yes, under certain conditions” as chosen.

Asked about the risk/probability of a scenario happening, Influenza pandemic, SARS/COVID-19, natural disasters and chemical incidences are perceived to be the most likely, whereas for Ebola, smallpox, dirty bombs, biological and nuclear incidences the likelihood is perceived as low. Regarding how dangerous a scenario was perceived, nuclear incidences, dirty bombs, bomb threats, and Ebola were the top scorer. The scenarios perceived as least dangerous were influenza, special influenza and SARS/COVID-19. See Figure 3. For both probability and danger, the range of answers was 0-100%; for standard deviations see Table 3.

Scenario	Risk/Probability	Danger	St.dev. Risk	St.dev. Danger
Natural disaster	49	46	28.73	25.12
Bombing	45	64	29.20	32.00
Influenza	68	41	27.00	23.17
bird flu	50	43	28.23	23.69
SARS/Covid	63	41	29.68	25.61
Ebola	27	60	25.34	32.21
Smallpox	28	51	23.15	31.88
Chemical incident	48	54	29.30	28.76
Biological incident	30	57	23.45	34.39

Nuclear incident	28	65	25.38	37.15
Dirty bomb	29	66	24.60	35.24
Mass shooting	45	52	30.45	31.38

Table 3. Risk/probability for a scenario to occur and the perceived danger to the HCW, as mean % and standard deviation (St.dev.)

Asked about previous training in disaster-related topics, 56 (54%) reported previous training in disaster management, 48 (47%) in epidemics/pandemics, 44 (43%) in chemical incidents, 22 (21%) in nuclear incidents and 60 (58%) in mass casualty situations.

Discussion

A study of the WTW in HCWs can help to identify demographic patterns and conditions which can have a great influence on the number of staff available in case of MCIs. Even within the limitation of this rather small questionnaire, the results seem to be consistent with previous studies and can support decisionmakers with ideas and priorities. The main findings of the study are a generally positive attitude regarding WTW, but many respondents had conditions. There were important conditions identified outside the hospital, such as e.g. the safety of one's family and inside the hospital as e.g. training and PPE.

The most positive rates for WTW were seen in pandemic scenarios, as shown in Fig. 1. This can be related to the fact that the COVID-19 pandemic from 2020 to 2023 (22) is still in memory, and an influenza epidemic is handled every year (23). Denmark did well during the COVID-19 pandemic, e.g. regarding the rate of excess monthly mortality from 2020 to 2023 in a European comparison (24). Danish HCWs have very limited experience with shootings, only in the greater Copenhagen area do they have some experience (25, 26), but other MCIs are rare in the past (27). Some of the scenarios might be unknown and at best based on theoretical knowledge, which is a further limitation.

The observed differences in WTW regarding education and gender can be connected, with nurses more often living in a partnership and having children at home. The safety of one's family and the provision of PPE seem to be the most important conditions, as shown in Figure 2. The lowest WTW with serious doubts or not willing to work at all was observed for dirty bombs and nuclear incidents. These scenarios are also perceived as unlikely but very dangerous as showed in Figure 3, even though no large numbers of casualties have been seen in the last decades (28).

In this survey, as well as in previous studies with the “fight or flight”-questionnaire from the Netherlands (14) and Saudi Arabia (10), there was not a scenario where all HCWs would attend to work unconditionally. The most recent study from Norway, which included police, fire, and rescue-personnel, and NGO-employees alongside HCWs, also showed similar findings (12). Our rates of WTW unconditionally were similar for most scenarios in comparison to the Netherlands but seem to be lower for dirty bombs and nuclear incidents. The low WTW in nuclear and radiological incidences can be associated with a very low level of training in these scenarios. A fear of the unknown might be a further explanation of this finding.

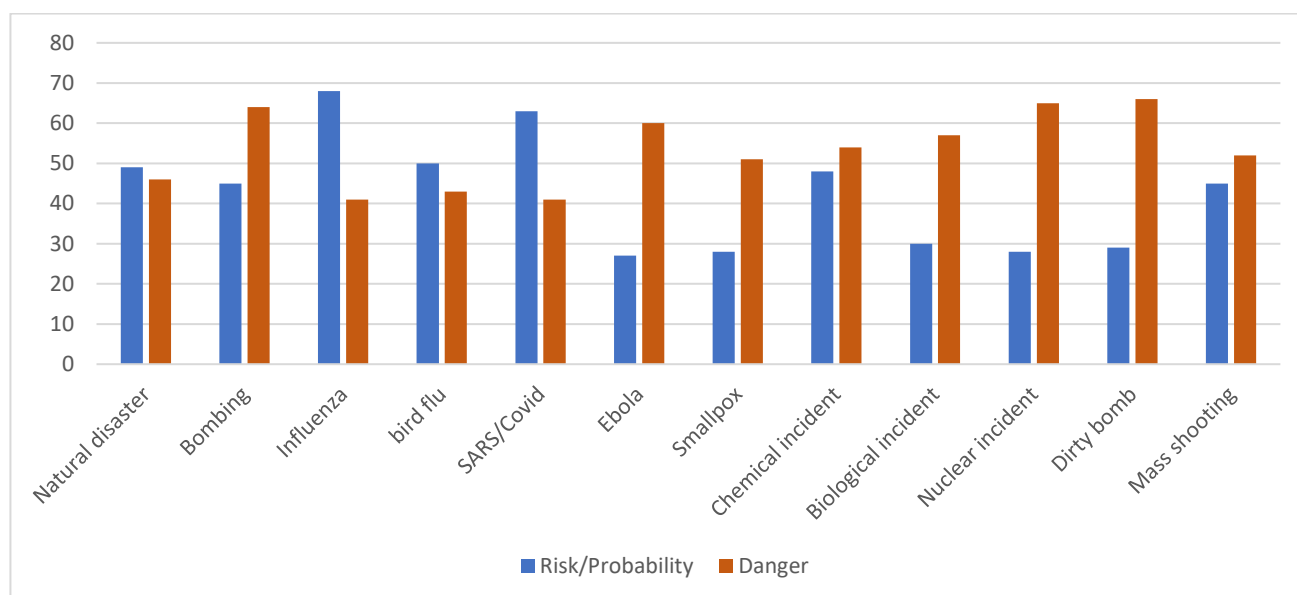


Figure 3. Risk/probability for a scenario to occur and the perceived danger to the HCW, as mean %

In comparison to Saudi Arabia, the Danish cohort seems less willing to work unconditionally in case of natural disasters. There were no natural disasters leading to an MCI in the last couple of years in Denmark, whereas Saudi Arabia has experienced natural disasters (29).

Previous training seems to have a positive correlation with WTW and could support further development of disaster training programs as one of the main interventions to improve WTW, as noted in a literature study from 2021 (29).

A major limitation of this study is the low number of participants and low response rate, which was underpowered regarding the power-calculation and compared to previous studies from the Netherlands and Saudi-Arabia. There can be numerous differences between responders and non-responders, but further analysis could not be performed. Data were only collected from two EDs within the same healthcare region, which makes the study vulnerable to local factors and limits the generalizability, but the EDs are independent from each other and had used different MCI-plans and training protocols

at the time of the study. 12 incomplete questionnaires were excluded from the analysis. Self-reporting bias can mislead descriptive statistics and causal inferences. The translation was not using the standard COSMIN (30), ISPOR (31) or EORTC (32) procedure, which can compromise the validity of the study. More focus on validation of the questionnaire after translation regarding content validity, construct validity and face validity would have improved the study. The questionnaire used did not focus on other relevant factors of WTW, such as religious values, group dynamics or mental toolkits, as identified in other publications (28).

Conclusion

This study suggests a high self-reported WTW in 12 different MCI scenarios. Many responders indicated that they would only come to work, if certain conditions were fulfilled. Based on the results, the following suggestions seem reasonable: A family support system, ensuring the safety of the healthcare workers' family should be integrated into disaster plans. The availability of relevant PPE should be ensured and communicated. Disaster training, also for rare scenarios, seems to be correlated with a higher WTW. Possible scenarios and conditions for work should be revised regularly, as new aspects may emerge.

Conflicts of Interest

The authors declare no conflicts of interest.

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DANSK TIDSSKRIFT FOR AKUTMEDICIN

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RESUMÉER AF AFHANDLINGER SUMMARIES OF DISSERTATIONS



Defended:

May 16, 2025

Author:

Stig Holm Ovesen  1,2,3

Supervisor:

Jesper Weile^{1,4}

Co-supervisors:

Søren Helbo Skaarup⁵,Rasmus Aagaard⁶Bo Løfgren^{1,7}, Hans Kirkegaard (*Initial Main Supervisor*)¹¹ Research Center for Emergency Medicine, Department of Clinical Medicine, Aarhus University, Palle Juul-Jensens Boulevard 99, Aarhus, Denmark.² Aarhus University Radiology Research Unit (AURA), Department of Clinical Medicine, Aarhus University, Palle Juul-Jensens Boulevard 99, Aarhus, Denmark.³ Emergency Department, Aarhus University Hospital, Palle Juul-Jensens Boulevard 99, Aarhus, Denmark.⁴ Emergency Department, Horsens Regional Hospital, Denmark.⁵ Department of Respiratory Diseases and Allergy, Aarhus University Hospital, Denmark.⁶ Department of Anesthesiology, Aarhus University Hospital, Denmark.⁷ Department of Internal Medicine, Randers Regional Hospital, Denmark.

Correspondence:

stigholm@clin.au.dk

Summary of dissertation

Point-of-care Ultrasound and Dyspnea in the Emergency

Department

Introduction

Dyspnea causes one in ten visits to the emergency department (ED), and half of the patients require hospitalization for 2 to 7 days. Discharge diagnoses commonly include 'Dyspnea - not otherwise specified', chronic obstructive pulmonary disease, pneumonia, heart failure, pulmonary embolism, and asthma. One out of twenty patients die during hospitalization, and one in ten dies within 30 days after discharge. Point-of-care ultrasound (POCUS) plays an increasing role in the initial diagnostic work-up of these patients and can help diagnose several of the common conditions causing dyspnea. Despite its everyday occurrence, surprisingly little is known about how the diagnostic work contributes to the health of the patients, and the adoption of POCUS, in this regard, tends to vary considerably between physicians.

HVAD VED VI?

Åndenød er en hyppig kontaktårsag i akutmodtagelser med betydelig morbiditet og mortalitet, og point-of-care ultralyd (POCUS) anvendes i stigende grad i den initiale diagnostik, om end evidensen primært er baseret på diagnostiske studier fremfor randomiserede forsøg.

Fact box (in Danish).

Aims

The studies in this PhD dissertation aimed to further understand whether a point-of-care ultrasound-driven diagnostic pathway compared to a usual diagnostic pathway improves and simplifies healthcare processes for emergency department patients with dyspnea.

Findings

Study I mapped the current evidence of point-of-care lung ultrasound in emergency medicine, with an emphasis on study designs and primary outcomes. Through systematic literature search, study selection, and extraction process, the key features of 406 relevant papers were displayed in an interactive online database. Overall, few randomized controlled trials had been conducted, and the majority of studies had primarily explored diagnostic accuracy research questions.

PERSPEKTIVERING

Resultaterne understøtter en fortsat, pragmatisk anvendelse af POCUS som supplement i udredningen af patienter med åndenød, med potentiale for mere effektiv diagnostik og ressourceanvendelse i danske akutmodtagelser.

Study II randomized 674 adult ED patients with dyspnea

Fact box (in Danish).

as chief complaint to either a POCUS-driven diagnostic pathway or a usual diagnostic pathway without in-ED focused lung and cardiac ultrasound. The intervention was not found to affect the hospital length of stay, including the primary outcome, alive and discharged within 24

hours. However, it reduced the utilization of chest X-rays and accelerated the physician's perceived diagnostic cer-

HVAD TILFØJER AFHANDLINGEN?

Afhandlingen viser, at en POCUS-drevet udredning ikke reducerer indlæggelsestid eller forbedrer tidlig udskrivelse, men kan mindske brugen af røntgen af thorax og øge den diagnostiske sikkerhed hos klinikerne.

Fact box (in Danish).

tainty.

Overall, the studies support and further justify POCUS's current role in the diagnostic workup of ED patients with dyspnea.

Conflicts of Interest

S.H. Ovesen reports lecture honoraria from the Danish Society for Ultrasound in General Practice; travel support from various emergency medicine and ultrasound societies (including WIN-FOCUS, EUSEM, IFEM, AGN, and DAFEM); DSMB membership for the HEAD-WISE trial; board positions at WINFOCUS and the Danish Medical Ultrasound Society; and an Associate Editor role at The Ultrasound Journal.

Funding

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Defended:

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Author:

Camilla Schade Skov^{1,2}

Principal supervisor:

Annmarie Touborg Lassen^{1,2}

Co-supervisors:

Mikkel Brabrand^{1,2}Dorthe Susanne Nielsen^{2,3}¹ Department of Emergency Medicine, University Hospital of Southern Denmark, Hospital Sønderjylland² Research Unit of Emergency Medicine, Department of Clinical Research, University of Southern Denmark, Denmark³ Department of Geriatric Medicine, Odense University Hospital

Correspondence:

Camilla.schade.skov@rsyd.dk

Summary of dissertation

Sepsis Impact

Introduction

Sepsis is defined as organ dysfunction caused by a dysregulated host response to infection. Although sepsis contributes significantly to overall mortality, the number of sepsis survivors has increased over the past years, resulting in an increased number of people living with possible long-term consequences, such as cognitive impairment, functional decline, muscle weakness and fatigue. Knowledge of post-hospital recovery is sparse, and no consensus on sepsis rehabilitation programmes exists. Knowledge about the post-sepsis sequelae experienced by sepsis survivors is essential in the pursuit of enhancing recovery from sepsis. A few qualitative studies have elucidated this subject; however, they have focused on sepsis survivors from the intensive care unit (ICU).

Health is a fundamental human right, but it is socially determined, which also applies to infectious diseases. Socioeconomic measures are difficult to obtain and interpret, especially due to differences in social inequality, social infrastructure and access to healthcare between countries. No Danish study has investigated the association between socioeconomic status and mortality in patients with sepsis.

WHAT DO WE KNOW?

Sepsis is a life-threatening condition with potential long-term consequences that extend beyond the acute state of illness.



In this PhD thesis, we sought to increase knowledge of sepsis burden and consequences related to sepsis at the patient level. With a qualitative approach, we explored how sepsis survivors experienced life in the aftermath of hospitalisation with sepsis.

In the qualitative study, we found that sepsis survivors often experienced fatigue and physical and psychological declines. Some survivors withdrew from social activities, were tormented by thoughts of death or had cognitive declines. All sepsis survivors, except one, had been treated outside the ICU. However, their experiences had substantial similarities to those previously described in sepsis survivors from the ICU.

In the second study (a register-based cohort study), we investigated whether low income was associated with an increased risk of death in patients with sepsis. Low income was associated with an increase in 90- and particularly 365-day mortality but was not identified in 7-day mortality. Patients from different income groups were referred to the ICU equally. Our results indicate that the increased risk of death among patients with sepsis and low incomes is mediated by a complex combination of out-of-hospital factors.

In the third study (a register-based cohort study), we described affiliations to the labour market among all patients with sepsis aged 20–63 years in the Region of Southern Denmark. Despite being of working age, only approximately 40% of the patients with sepsis were part

of the active workforce at hospitalisation. Factors associated with return to work (RTW) among patients with sepsis who were part of the workforce at admission included patient characteristics such as lower age and lower Charlson Comorbidity Index, no major mental illness, no markers of smoking, no alcohol-related disorders and a high educational level. Further, hospital stays of less than 7 days and no admission to the ICU were also associated with RTW. By far, the strongest factor associated with RTW was whether one was working before hospitalisation, which ruled out the impact of other factors, including educational level.

Our research provides a more comprehensive understanding of sepsis trajectories at the individual level. The outcome after sepsis depends, to some extent, on ‘who you were’ before becoming sick. Understanding what

APPLICATION IN DANISH EMERGENCY DEPARTMENTS

Outcomes after sepsis are influenced not only by the severity of the acute illness but also by socioeconomic factors and pre-existing labour market attachment. Sepsis survivors experience long-term cognitive, physical, and psychological impairments that affect everyday life after hospital discharge.

matters most to sepsis survivors can contribute to an increased quality of post-hospital care and rehabilitation programmes. Increased awareness of socioeconomic disparities can potentially improve existing inequality in healthcare; however, improved equality in health requires understanding the impact of out-of-hospital factors.

CLINICAL IMPACT

Early identification of patients with sepsis who are at increased risk of poor long-term outcomes may enable targeted follow-up and rehabilitation.

Conflicts of Interest

The authors declare no conflicts of interest.

Funding

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Forsvaret:

28. februar 2025

Forfatter:

Stine Fjendbo Galili^{1,2} 

Vejledere:

Lone Nikolajsen^{1,2}Hans Kirkegaard^{1,2}Bodil Hammer Bech^{1,2}Jette Ahrensberg^{1,2}¹ Aarhus Universitetshospital,
Aarhus, Danmark² Aarhus Universitet, Aarhus,
Danmark

Korrespondance:

s.galili@clin.au.dk

Resumé af afhandling

Acute Pain Treatment in the Emergency Department

Introduktion

Akutte smerter er blandt de hyppigste årsager til kontakt i akutafdelingen, men trods øget opmærksomhed er utilstrækkelig smertebehandling fortsat et klinisk problem. Dette gælder især patienter med et dagligt opioidforbrug, hvor udvikling af opioidtolerance og opioidinduceret hyperalgesi kan vanskeliggøre effektiv smertelindring. Samtidig kan usikkerhed omkring passende opioiddosering og bekymring for bivirkninger eller afhængighed bidrage til underbehandling. Der er derfor behov for bedre evidens for både individualiseret opioidbehandling og multimodale analgetiske strategier i akutmodtagelsen.

Formål

Denne ph.d.-afhandling undersøger centrale udfordringer inden for akut smertebehandling gennem tre komplementære studier med fokus på patienter med akutte smerter i akutafdelingen. Formålet var dels at beskrive den eksisterende kliniske praksis for opioidbehandling hos patienter med dagligt opioidforbrug, dels at undersøge den tilgængelige evidens for lavdosis ketamin som supplement til opioider og endelig at evaluere effekten af lavdosis ketamin som tillæg til morfin i et randomiseret klinisk forsøg.

Resultater

Det første studie viste, at en tredjedel af patienter med dagligt opioidforbrug modtog en PN-opioiddosis, som var lavere end anbefalet, i forhold til deres sædvanlige opioidforbrug. Risikoen for utilstrækkelig dosering steg med stigende daglig opioiddosis, hvilket peger på et forbedringspotentiale i den akutte behandling af denne patientgruppe.

Det systematiske review og metaanalysen samlede den eksisterende evidens for lavdosis ketamin som supplement til opioider ved akutte smerter i akutafdelingen. Samlet viste analysen en besked, men statistisk signifikant reduktion i smerteintensitet samt et lavere behov for supplerende opioidbehandling sammenlignet med opioider alene.

HVAD TILFØJER AFHANDLINGEN?

- En tredjedel af patienter med dagligt opioidforbrug modtager utilstrækkelige PN-opioiddoser.
- Lavdosis ketamin forbedrer den tidlige smertelindring, når det gives som supplement til morfin.
- Effekten ses både hos patienter med og uden dagligt opioidforbrug.

HVAD VED VI?

- Utilstrækkelig smertebehandling er fortsat hyppig i akutafdelinger.
- Patienter med dagligt opioidforbrug har øget risiko for utilstrækkelig analgesi.
- Lavdosis ketamin anbefales i flere internationale retningslinjer som led i multimodal smertebehandling.
- Lavdosis ketamin anbefales i flere internationale retningslinjer som led i multimodal smertebehandling.

Evidensen var dog præget af metodologisk heterogenitet, og patienter med dagligt opioidforbrug var ikke inkluderet i de eksisterende randomiserede studier.

Denne patientgruppe blev adresseret i afhandlingens randomiserede, dobbeltblindede studie, hvor patienter med og uden dagligt opioidforbrug blev inkluderet. Tillæg af lavdosis ketamin til intravenøs morfin resulterede i en hurtigere og større reduktion i smerteintensitet end morfin alene, og effekten blev observeret uafhængigt af patienternes opioidstatus. Behandlingen var forbundet med flere kortvarige psykomimetiske bivirkninger umiddelbart efter administration, men der blev ikke fundet forskelle i alvorlige bivirkninger, respiratoriske komplikationer, sedation eller patienttilfredshed.

Samlet bidrager afhandlingen med ny klinisk evidens for håndteringen af akutte smerter hos patienter med og uden dagligt opioidforbrug. Resultaterne dokumenterer dels, at patienter med højt opioidforbrug fortsat risikerer utilstrækkelig smertebehandling i akutafdelingen, dels at lavdosis ketamin som supplement til morfin kan forbedre den tidlige analgesi uden væsentlige sikkerhedsmæssige problemer. Afhandlingen understøtter dermed en mere

individualiseret og multimodal tilgang til akut smertebehandling og bidrager med et evidensgrundlag for fremtidige kliniske retningslinjer og implementering i danske akutmodtagelser.

Interessekonflikter

Forfatteren angiver ingen interessekonflikter.

Finansiering

Ingen.

PERSPEKTIVERING

- Resultaterne understøtter mere individualiseret opioiddosering hos opioidtolerante patienter.
- Lavdosis ketamin kan indgå som en del af multimodal smertebehandling ved svære akutte smerter.
- Afhandlingen bidrager med klinisk evidens, som kan anvendes ved udvikling af lokale og nationale behandlingsvejledninger.

Defended:
May 9, 2025

Author:
Trine Worm Thøgersen¹

Vejledere:
Marianne Lisby¹
Mette Geil Kollerup^{2,3}
Patricia Dykes⁴
Sidsel Vinge⁵

¹ Research Center for Emergency
Medicine, Aarhus University Hos-
pital, Denmark

² University College Northern Jut-
land, Denmark

³ Clinical Nursing Research Unit,
Aalborg University Hospital, De
nmark

⁴ Brigham and Women's Hospital
Boston, MA, USA

⁵ Self-employed consultant

Correspondence:
trthoe@rm.dk

Summary of dissertation

Potentially Preventable Hospitalisations – Insights from Registries and Frontline care

Background

Potentially preventable hospitalisations, often defined through ambulatory care-sensitive conditions (ACSCs), serve as an indicator of healthcare system performance. However, understanding the mechanisms behind these admissions requires a multi-level perspective, incorporating micro (individual), meso (organisational), and macro (policy) factors.



Aim

This thesis aims to provide a comprehensive understanding of potentially preventable hospitalisations by examining their underlying mechanisms across system levels.

Methods

The thesis comprises three studies: two register-based studies investigating the characteristics of older persons hospitalised with ACSCs and the impact of multimorbidity on readmissions and mortality, and an ethnographic study exploring healthcare aides' practices in supporting older persons with chronic obstructive pulmonary disease at risk of ACSC-related admissions.

WHAT DOES THE PAPER ADD?

This thesis demonstrates that multimorbidity substantially increases the risk of readmission and mortality and shows how healthcare aides in the home care setting play a key role in preventing admissions, although their impact is conditioned by organisational constraints and interprofessional dynamics.

Findings

The findings highlight that ACSC-related admissions are influenced by a complex interplay of patient characteristics, healthcare structures, and system-level factors. The register-based studies show that multimorbidity significantly affects the risk of readmission and mortality, underscoring the need for tailored interventions. The ethnographic study reveals that healthcare aides play a crucial role in bridging gaps in care, but their ability to prevent hospitalisations is shaped by organisational constraints and professional relationships.

WHAT DO WE KNOW?

Potentially preventable hospitalisations, particularly those related to ACSCs, are widely used as an indicator of healthcare system performance and are influenced by individual health status as well as organisational and policy-level factors

Conclusion

Preventing ACSC-related admissions requires a system-wide approach that acknowledges the interdependence of micro-, meso-, and macro-level factors. The knowledge generated in this thesis can inform clinicians, managers, and policymakers in developing targeted strategies that consider the contextual and structural dimensions of ambulatory care sensitive conditions.

Conflict of Interest

The author declares that they have no conflicts of interest.

Funding

None.

CLINICAL IMPACT

Potentially preventable hospitalisations, particularly those related to ACSCs, are widely used as an indicator of healthcare system performance and are influenced by individual health status as well as organisational and policy-level factors.

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PROTOKOLARTIKLER
RESEARCH PROTOCOLS



RESEARCH PROTOCOL

OPEN ACCESS Development and Implementation of AI Triage Models in
Emergency Departments: A Scoping Review ProtocolUswa Nissar Anjum^{1,2*}  | Cecilie Blomberg Hvid¹  | Ove Andersen² Jeanette Wassar Kirk^{2,3}  | Michael Dan Arvig ^{1,4,5}

¹Department of Emergency Medicine, Slagelse Hospital, Denmark. ²Department of Clinical Research, Amager and Hvidovre Hospital, Denmark. ³Department of Health and Social Context, National Institute of Public Health, University of Southern Denmark, Odense, Denmark ⁴Department of Clinical Medicine, University of Copenhagen, Denmark. ⁵Department of Regional Health Research, University of Southern Denmark, Odense, Denmark.

Correspondence (*): uswa.anjum@regionh.dk

Abstract

Background: Triage is a critical clinical tool in emergency care, ensuring appropriate prioritization of patient care. However, traditional triage systems face challenges such as mistriage, resource misallocation, and overcrowding. Evaluation of triage accuracy also lacks a universal reference standard, making comparisons across studies challenging. Artificial intelligence (AI) has shown potential to enhance triage accuracy, mitigate human limitations, and optimize resource allocation. However, routine integration into clinical workflows remains limited, as uptake depends on staff-related factors such as usability, trust, and organizational readiness. Therefore, there is a need to synthesize evidence on both performance and implementation determinants.

Objective: This scoping review compares AI-based triage with conventional/non-AI triage among adults in prehospital and emergency department settings, focusing on implementation determinants as well as performance outcomes. The dual focus on quantitative and qualitative aspects seeks to provide actionable insights for the effective development and integration of AI tools in emergency care.

Methods: The review will follow the Joanna Briggs Institute methodology and the PRISMA-ScR reporting guidelines to ensure transparency. We will search PubMed (MEDLINE), Embase (Ovid), Cochrane Central Register of Controlled Trials (Wiley), Web of Science (Clarivate), Scopus (Elsevier), and grey literature via Google Scholar and ProQuest using four core concepts: AI, triage, emergency medicine, and implementation. We will include studies of adult patients comparing AI-based triage with conventional/non-AI triage in prehospital and emergency department settings. Two reviewers will independently screen titles/abstracts and full-text articles and extract data in Covidence®, with a third reviewer resolving disagreements. Quantitative findings will be summarized descriptively in tables/figures, and heterogeneity in triage accuracy definitions and reference standards will be described explicitly rather than pooling non-comparable measures. Qualitative findings will be synthesized thematically and structured using the *Consolidated Framework for Implementation Research* (CFIR).

Discussion: This review will map AI-based triage models and key gaps in design, clinical effectiveness, and implementation across prehospital and in-hospital emergency care. By integrating quantitative and qualitative insights, it will bridge theory and practice, guide future research, and foster human-AI collaboration. Findings may inform the development of more effective AI tools that can be integrated into clinical workflows and strengthen acute patient care.

Keywords: Artificial intelligence; Triage; Emergency care



Introduction

Triage is a well-established and widely used clinical tool for prioritizing patients in emergency care (1). Despite ongoing refinements, it still faces major challenges in achieving optimal effectiveness, particularly mistriage, which is characterized by incorrect triaging, either as overtriage (2) or undertriage (3). Triage accuracy depends on the model design and the real-world context in which it is applied. Staff experience and training, subjective judgment, and high inter-rater variability are significant drivers of mistriage (4,5), occurring in around one third of emergency department (ED) visits in large cohort studies (6,7), affecting patient safety, resource allocation, and ED waiting times, potentially exacerbating overcrowding and further increasing risk of mistriage (8). Additionally, defining triage accuracy is difficult because there is no universally accepted reference standard for true acuity, and studies use different reference points (e.g., expert review, clinical outcomes or decisions, or resource use) (9).

Artificial intelligence (AI) has shown promising results in emergency medicine because it can process large quantities of complex data, overcome human limitations such as cognitive fatigue and bias, and predict clinical outcomes (10). Data-driven triage systems typically use Machine Learning (ML) and Deep Learning (DL), with ML employing statistical algorithms and DL using neural networks to identify patterns and make predictions (11,12). These AI tools can alleviate the growing workload of triage staff, aiding in the reduction of mistriage, diagnostic errors, overcrowding, and improving resource allocation (7,12).

Despite their potential, AI models are not widely integrated into emergency care globally, mainly because many are developed without a clear implementation focus, and clinician mistrust of data-driven methods persists (11). To translate AI models into improved clinical practice, development should be guided by clinicians' perspectives throughout the process to foster human-machine interaction (13). Seamless workflow integration is critical, and implementation science plays a pivotal role

in facilitating the adoption of evidence-based practices and bridging the gap between academic research and clinical implementation (14,15).

HVAD VED VI?

- AI-modeller kan forbedre triage nøjagtighed, optimere patientsikkerhed og ressourceallokering.
- Klinisk personale er ofte skeptisk over for AI-værktøjer, hvilket påvirker implementering og accept.
- Mange AI-modeller er udviklet uden fokus på praktisk integration i kliniske arbejdsgange.

Fact box (in Danish).

To comprehensively evaluate AI-based triage in emergency care, both quantitative and qualitative evidence must be assessed with equal rigor. The quantitative component focuses on performance metrics as well as clinical and operational outcomes of AI models compared with conventional triage. The qualitative aspect examines contextual and human-centered factors associated with implementation, such as clinicians' perceptions, trust and experiences with AI systems, and the organizational, structural and workflow challenges of integrating these tools into the complex dynamics of emergency medicine.

Although several recent reviews of AI triage acknowledge implementation barriers (16,17), they do not generally treat implementation as a primary search concept, which may limit the systematic capture of evidence on real-world adoption. Our review addresses this gap by moving beyond model performance alone and examining the wider implementation context of AI-based triage across prehospital and ED settings. By considering factors that shape real-world uptake, including barriers and facilitators, the review aims to provide a more complete understanding of what is required for successful integration into clinical practice.

In this scoping review, we will assess how AI-based triage systems compare with conventional/non-AI triage in prehospital and in-hospital emergency care for adult patients, focusing on implementation determinants as well

as performance outcomes. This dual approach will provide a comprehensive overview of the field by identifying gaps in real-world applicability and acceptance as well as in technical performance, thereby informing future research and supporting the development and implementation of AI-based triage models in emergency medicine.

Methods

This scoping review will be conducted in accordance with the Joanna Briggs Institute (JBI) methodology for scoping reviews (18), which is well suited to mapping a broad and heterogeneous evidence base. Reporting will follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines to ensure transparency throughout the process (19). Before commencing the review, the protocol has been registered with the Open Science Framework to support transparency and reproducibility (DOI: [10.17605/OSF.IO/MCPY4](https://doi.org/10.17605/OSF.IO/MCPY4)).

We will include studies of adults (≥ 18 years) in emergency care. The primary intervention of interest is general AI-based triage models used in prehospital and ED settings, with comparisons made to conventional or non-AI triage. Prehospital triage will be included because it often informs ED patient allocation and, in some settings, is used on arrival without re-triage.

We will exclude studies limited to disease-specific prediction (e.g., sepsis-only tools), models without a relevant comparator, and studies from specialty-specific settings (e.g., radiology and cardiology), to maintain comparability given that specialized triage systems are designed for specific departments or subspecialties.

We will include primary qualitative, quantitative, and mixed-methods studies. Eligible quantitative designs will include randomized controlled trials, diagnostic accuracy studies, and prospective or retrospective observational studies. We will also include qualitative and mixed-methods studies reporting barriers and facilitators to the implementation of AI-based triage models, even when technical algorithm details are limited, as these data are

directly relevant to the qualitative aims of the review. We will exclude conference abstracts, editorials, lecture notes, reviews, and other forms of secondary literature.

To ensure relevance, we will include only studies published within the past ten years in English, Danish, Swedish, or Norwegian. Preliminary searches identified no eligible studies before this period, which aligns with the recent growth of triage-focused AI models in prehospital and ED settings. Because our review also includes implementation factors, it is important that the included studies reflect more recent organizational and digital contexts in which implementation is realistically feasible.

INFORMATION SOURCES

A comprehensive search will be conducted in the following bibliographic databases: PubMed (MEDLINE), Embase (Ovid), Cochrane Central Register of Controlled Trials (Wiley), Web of Science (Clarivate), and Scopus (Elsevier). The preliminary selected controlled vocabulary and free-text terms for PubMed are shown in *Table 1*. We will also search for grey literature in Google Scholar and ProQuest to minimize publication bias.

SEARCH STRATEGY AND TERMS

The search strategy will be developed and revised in collaboration with an experienced information specialist. It will focus on four core concepts: *artificial intelligence*, *triage*, *emergency medicine*, and *implementation*, combined using appropriate Boolean operators (AND/OR). The strategy will be piloted and refined in PubMed (MEDLINE) before being applied across all databases, and a detailed search log will be maintained to ensure transparency.

SCREENING AND SELECTION OF SOURCES OF EVIDENCE

All records will be imported into Covidence® (Veritas Health Innovation, Melbourne, Australia) for de-duplication, screening, and data extraction. Two reviewers will independently screen titles and abstracts against the eligibility criteria. Any discrepancies will be resolved by discussion, with a third reviewer adjudicating if needed.

Subsequently, the same two reviewers will independently assess the full-text articles, and reasons for exclusion will be recorded. To illustrate the selection process from initial identification to final inclusion, a PRISMA flow diagram will be presented in the final manuscript.

DATA EXTRACTION

A standardized, pilot-tested data-charting form will be developed to ensure consistent and comprehensive extraction. It will capture study characteristics, patient population, AI-based triage model characteristics, comparator triage approach, and the prespecified quantitative outcome domains, along with qualitative implementation determinants (*Table 2*).

QUANTITATIVE MAPPING: We will extract and summarize reported clinical outcomes (mortality, length of stay, readmission), operational outcomes (crowding, waiting times), triage accuracy metrics, and reported effectiveness. We will also describe key model characteristics, including data inputs, model type, and performance, as reported in each study, without analyzing underlying algorithmic mechanisms. Given that “triage accuracy” is variably defined across studies and may be benchmarked against different reference standards, we will record each study’s definition and reference standard and interpret results in light of this heterogeneity rather than directly comparing non-equivalent metrics.

ANVENDELSE I DANSKE AKUTMODTAGELSER

1. Understøtte beslutningstagning for klinisk personale ved at reducere fejl og forudsige kliniske udfald mere præcist.
2. Fremme uddannelse og tillid til AI-baserede værktøjer blandt sundhedspersonale.
3. Tilpasse AI-modeller til de unikke behov i danske akutafdelinger for at støtte en succesfuld integration og implementering af AI i de kliniske arbejdsgange.

Fact box (in Danish).

QUALITATIVE MAPPING: To capture implementation evidence more systematically than prior reviews, we will include “implementation” as a core search concept and synthesize qualitative and mixed-methods studies reporting adoption of AI-based triage models.

HVAD TILFØJER STUDIET?

- Overblik over evidens for AI-baserede triagemodeller til voksne i præhospitalt arbejde og på akutmodtagelser, sammenlignet med konventionel/non-AI triage.
- Identifikation af videnshuller i teknisk ydeevne, kliniske resultater og implementeringsbarrierer.
- Indsigt i både kvantitative og kvalitative aspekter for bedre forståelse af AI-triages potentiale og udfordringer.

Fact box (in Danish).

Implementation-related data will be extracted even when technical model details are limited. We will perform an in-depth qualitative mapping of implementation determinants, covering both staff-related factors (acceptability, attitudes, perceptions, interprofessional relations) and contextual factors (stakeholder engagement, workflow, organizational culture and readiness). An implementation scientist embedded within the research team will lead this work, ensuring methodologically rigorous application of implementation terminology and framework-based synthesis. We will structure implementation findings using the *Consolidated Framework for Implementation Research* (CFIR) to organize determinants of implementation success and ensure consistent interpretation (20).

Two reviewers will independently extract data from the first 20 references, then compare and discuss the results to ensure consistency and refine the extraction approach. Any disagreements or uncertainties will be addressed by the entire research team. Data charting will proceed iteratively, and the form will be updated if new relevant variables emerge during extraction.

As this is a scoping review, we will not conduct a formal risk-of-bias assessment (19).

DATA SYNTHESIS

We will synthesize findings using an integrated approach that combines descriptive quantitative summarization with qualitative thematic synthesis. Quantitative data will be summarized using descriptive statistics and presented in tables and figures to provide a visual representation of the scope and trends in the literature, including study and population characteristics, AI model features, comparator triage approach, and prespecified outcome domains. Because outcome definitions and reference standards, particularly for triage accuracy, vary across studies, we will record each study's definition and reference standard and interpret findings in light of this heterogeneity rather than pooling non-equivalent metrics.

Qualitative and mixed-methods evidence will be analyzed thematically and synthesized narratively. CFIR will then be applied pragmatically to support consistent categorization of implementation determinants across heterogeneous study designs. Not all CFIR domains are expected to be represented, reflecting the reporting depth of the studies included. Findings will be organized and reported by key implementation themes (e.g., barriers and facilitators to adoption) and relevant contextual domains, and evidence gaps will be explicitly highlighted to inform future development and implementation of AI-based triage models.

Discussion

This scoping review will offer a novel and comprehensive overview of AI-based triage models and their implementation in emergency care, addressing aspects that are often difficult to synthesize or map in systematic reviews.

By summarizing clinical and operational outcomes, triage accuracy, and reported effectiveness, alongside model characteristics and comparator triage methods, the review will clarify what has been studied, how outcomes are defined, and where evidence is robust or inconsistent. A particular contribution is to document and interpret

heterogeneity in triage accuracy definitions and reference standards, rather than comparing non-equivalent metrics.

In parallel, we will synthesize qualitative and mixed-methods evidence on barriers and facilitators to adoption, using CFIR to support implementation-relevant interpretation. This dual focus is intended to move beyond performance-only summaries by highlighting the practical conditions for real-world uptake and identifying gaps in implementation evidence to inform future design and deployment strategies for more effective AI-based triage tools.

In conclusion, this review will map evidence, identify key patterns and gaps, and summarize evaluated outcomes and implementation determinants influencing real-world uptake. Findings will guide future research priorities and support more implementable AI innovations in emergency care.

Conflicts of Interest

The authors declare no conflicts of interest.

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CASE REPORTS / KASUISTIKKER



CASE REPORT / KASUISTIK

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Mycoplasma Pneumonia Induced Rash and Mucositis (MIRM), en overset differentialdiagnose til alvorligere hudsygdom

Mycoplasma Pneumonia Induced Rash and Mucositis (MIRM), an overlooked benign differential diagnosis for severe skin diseases

Karen Dørffler Bjerrum^{1*}  | Emilie Fraisse¹  | Anne Kragh Hansen² 

Rasmus Gregersen Mottlau¹ 

¹Akutafdelingen, Københavns Universitetshospital – Bispebjerg og Frederiksberg, København, Danmark. ²Dermatologisk Afdeling, Københavns Universitetshospital – Bispebjerg og Frederiksberg, København, Danmark.

Korrespondance (*): karenp_109@hotmail.com

Resumé

Mycoplasma pneumoniae er en almindelig årsag til samfundserhvervet pneumoni. I sæsonen 2024–2025 blev der registreret over 40.000 laboratoriebekræftede tilfælde i Danmark – det højeste antal i over et årti [1]. *Mycoplasma pneumoniae* kan også medføre ekstrapulmonale komplikationer. I 2015 blev *Mycoplasma pneumoniae* Induced Rash and Mucositis (MIRM) første gang beskrevet som en samlebetegnelse for tilstedeværelsen af mukositis med eller uden mild hudinvolvering hos patienter med bekræftet *Mycoplasma pneumoniae*-infektion. Mukositis kan inkludere konjunktivitis, orale-, okkulære- og genitale erosioner, vesikler og bullae og i svære tilfælde konjunktivale ulcerationer. Mundslimhinden og øjnene er næsten altid involveret.

MIRM er en selvlimiterende, sjælden komplikation til *Mycoplasma*-pneumoni, der især rammer børn og unge voksne. Udover antibiotika mod infektionen, kan MIRM lindres med topikale kortikosteroider, analgetika, systemisk antihistamin og i svære tilfælde systemiske kortikosteroider.

English abstract

Mycoplasma induced rash and mucositis (MIRM) was described for the first time in 2015 as a collective term for patients with dermatological complications to a *mycoplasma pneumoniae* infection. MIRM is a differential diagnosis for erythema multiforme, Steven Johnson syndrome and toxic epidermal necrolysis. However, MIRM has a significantly more benign prognosis. If the patients are wrongly diagnosed with more complicated differential diagnoses, over treatment might occur, an untreated *mycoplasma pneumoniae* infection might be overlooked, and the patient might be incorrectly diagnosed with an adverse drug reaction. We describe a case with a 21-year-old male with MIRM. The patients developed conjunctival ulcerations and oral and genital mucositis. Treatment included topical and systemic steroids.

Nøgleord/Keywords: Ekstrapulmonale komplikationer / Extrapulmonary complications; *Mycoplasma pneumoniae* inducerede rash og mukositis (MIRM) / *Mycoplasma pneumoniae* Induced Rash and Mucositis (MIRM); Nekrose af mundslimhinde / Oral mucosa necrosis; Konjunktivitis / Conjunctivitis

Introduktion

En 21-årig tidligere rask mand, uden kendte allergier, sås i akutmodtagelsen med 1,5 døgnsvarende smertefulde blærer i munden, synkesmerter, kvalme og kulderystelser. To dage forinden var han ved egen læge opstartet i Roxitromycin 300 mg x 1 dagligt mod PCR-verificeret *Mycoplasma-pneumoni*. I akutafdelingen berettede patienten kun orale klager, og oplevede klinisk bedring i de pulmonale symptomer. Patienten var afebril og havde stabile vitalparametre. Oralt fandtes der nekrotiske blærer langs vestibulum oris og multiple papler på den bløde gane (Figur 1).



Figur 1. Cavum oris. Billeder bragt med tilladelse fra patienten.

Læberne var tørre og afskallende. Paraklinisk målt CRP 128 mg/L og leukocytter $8,5 \times 10^9/L$. På mistanke om MIRM blev der ordineret tablet Prednisolon 25 mg dagligt med ambulant dermatologisk opfølgning. I de efterfølgende dage udviklede patienten bilaterale konjunktivale hæmatomer, afstødning af øjets konjunktiva, mukositis på collum penis og i skrotum, spredte overfladiske sår på ekstremiteterne og forværring af slimhindeforandringerne i cavum oris. Behandlingen blev intensiveret med tablet Prednisolon 50 mg dagligt i 3 dage, tablet antihistamin og morfin, suppleret med steroid- og antibiotikaholdige øjendråber samt steroidholdig mundhulegel (Tabel 1).

Handelsnavn	Dispensering	Type	Dosis
Prednisolon	Tablet	Kortikosteroid	Dag 0-1: 25 mg x 1 dgl Dag 2-4: 50 mg x 1 dgl Herefter nedtrapning hver 7. dag til hhv. 37,5 mg, 25 mg, 15 mg, 10 mg og 5 mg, alle x 1 dgl.
Dermovat	Salve til mundhulen	Kortikosteroid gr. 4	Dag 0-1: 1 påsmøring x 2 dgl, Dag 2 - 30: 1 påsmøring x 1 dgl. Autoseponeret efter ca. 1 md.
Specadex	Øjendråber	Kortikosteroid (dexamethason) + antibiotika (kloramfenikol)	Dag 4-6: 1 dr. x 4 dgl. Dag 7-16: 1 dr. x 6 dgl. Dag 17- 35: 1 dr. x 3 dgl. Bivirkning med øget intraokulært tryk. Dag 36-38: 1 dr. x 2 dgl. Dag 39-43: 1 dr. x 1 dgl.
Kloramfenikol	Øjensalve	Antibiotika, bredspektret	Dag 2-3: 1 stribe x 5 dgl. Seponeres ved opstart af Specadex.
Azyter	Øjendråber	Antibiotika, makrolid	Dag 4-6: 1 dr. x 2 dgl.

Tabel 1. Fast medicin som behandling i sygehistorien.

Dertil fik patienten i det akutte forløb ved behov: tablet Oxycodon 5 mg (opioid), tablet Paracetamol (paracetamol), tablet Ibuprofen (NSAID), Andolex (NSAID mundhulegel), tablet Telfast (antihistamin) og lubrikerende øjendråber.

HVAD VED VI?

- MIRM er en sjælden komplikation til *Mycoplasma pneumoniae*-infektion defineret ved udtalt mukositis og begrænset eller ingen hudinvolvering.
- Identifikation af MIRM og opstart af relevant behandling kan reducere symptomer og bekymringer samt forebygge komplikationer og unødvendige undersøgelser.
- Det er vigtigt at skelne MIRM fra alvorlige differentialdiagnoser som erythema multiforme og SJS/TEN og planlægge tæt monitoring i tvivlstilfælde.

Symptomerne toppede omkring dag seks efter første hospitalkontakt, svarende til 2–3 uger efter debut af luftvejssymptomer. Patienten endte med at modtage systemisk Prednisolon i 37 dage og al behandling foregik ambulant. Ét år efter debut var han i velbefindende, men angav pigmentforandringer på armen, benet og skrotum.

Diskussion

MIRM er en sjælden og formentligt overset tilstand, som især ses blandt børn og unge voksne. Diagnosen understøttes af positiv serologi, PCR eller dyrkning for *Mycoplasma pneumoniae* [2,3]. Et systematisk review har vist, at 34% af MIRM-patienter udelukkende havde mukositis, 47% af havde mild, overfladisk hudinvolvering (<10% af kropsoverfladen) og 19% havde moderat hudinvolvering [2]. MIRM manifesterer sig også urogenitalt og kan ubehandlet give strikturer, vandladningsgener, smerter og dyspareuni. Grundet mulig blufærdighed er det vigtigt at spørge direkte ind til disse symptomer. Differentialdiagnoser til MIRM afhænger af patientens præsentation, og omfatter bl.a. herpes simplex virus, allergisk- og infektiøs konjunktivitis, seksuelt overførte sygdomme, lægemiddelbivirkning og alvorligere diagnoser såsom erythema multiforme og Stevens-Johnsons syndrom (SJS) /

toksisk epidermal nekrolyse (TEN). MIRM adskiller sig fra de tre sidstnævnte ved at have *Mycoplasma pneumoniae* som den udløsende agens, mens det ved erythema multiforme er viralt betinget og SJS/TEN medicinudløst. Derudover fremstår MIRM typisk med udtalt mukositis, begrænset eller ingen hudinvolvering og pulmonale symptomer [2-5]. Differentieringen er vigtig, da SJS/TEN har en mortalitet på 24-49% i modsætning til få/ingen dødsfald ved MIRM [2].

HVAD TILFØJER CASEN?

Øget kendskab til MIRM, som er en forholdsvis nylig defineret diagnose, og formentligt ofte overset.

Ved tvivl om diagnosen, er det vigtigt at planlægge tæt kontrol af tilstandens udvikling, evt. i oftalmologisk, dermatologisk, gynækologisk og/eller urologisk regi [5], hvilket også var tilfældet i sygehistorien. Samlet talte den dominerende slimhindeaffektion, begrænsede hudinvolvering og den påviste *Mycoplasma pneumoniae*-infektion for MIRM fremfor SJS/TEN. Efter det akutte sygdomsforløb opnår omkring 81% af patienter komplet remission. De resterende 19% kan efterfølgende opleve tørre øjne, pigmentforandringer eller slimhindestrikurer.

PERSPEKTIVERING

- Forudgående luftvejssymptomer som hoste, feber og almen utilpashed er almindelige symptomer på *Mycoplasma pneumoniae*-infektion, og bør rejse mistanke om MIRM ved patienter med mukositis (som ses i akutmodtagelser), især i perioder med epidemi.
- Genkendelse af MIRM og tidlig initiering af korrekt behandling og opfølgning kan mindske risikoen for komplikationer og varige mén for patienterne.

Interessekonflikter

Forfatterne angiver ingen interessekonflikter.

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CASE REPORT

OPEN ACCESS

Atypical Lemierre's syndrome with pleural infection

Michael Dan Arvig^{1,2,3} 

¹Akutfdelingen, Slagelse Sygehus, Slagelse, Danmark ²RESCUE (Research Entity for Studies in Clinical Acute Medicine), Syddansk Universitet, Odense, Danmark ³Københavns Universitet, København, Danmark
Korrespondance (*): doktorarvig@gmail.com

Abstract

A 25-year-old woman presented to the emergency department with dyspnea after recent sore throat and failed antibiotic treatment. Point-of-care lung ultrasound revealed consolidation and pleural effusion, and cultures grew *Fusobacterium necrophorum*. CT showed no thrombosis in the internal jugular vein. The case highlights atypical Lemierre's syndrome, the value of history-taking, point-of-care ultrasound, and early pleural aspiration.

Keywords: Lemierre's syndrome; Pleura infection, *Fusobacterium necrophorum*; Point-of-care ultrasound; Oropharyngeal symptoms; Internal jugular thrombosis

Introduction

Lemierre's syndrome (LS) is a rare condition with an annual incidence of 3.6 per million and typically affects teenagers and young adults [1]. LS often begins as an oropharyngeal infection and is complicated by thrombophlebitis of the internal jugular vein with spreading to other organs, commonly the lungs [2]. If not recognized and treated in a timely manner, it carries a high mortality [3].

In this case report, an atypical form of LS is described, highlighting diagnostic skills and targeted therapy in the emergency department (ED).

WHAT DO WE KNOW?

Lemierre's syndrome typically consists of throat symptoms, thrombosis of the internal jugular vein with hematogenous spread, most commonly to the lungs.



Case presentation

A 25-year-old previously healthy woman was admitted to the ED due to worsening dyspnea. Three weeks earlier, she had developed a sore throat. On evaluation by her general practitioner, she had dyspnea, cough, sputum, and a C-reactive protein (CRP) of 100 mg/L. Phenoxymethylpenicillin had been administered for five days but had no effect, and CRP continued to increase.

At arrival in the ED, she was alert. No dyspnea at rest or while speaking. Pneumonia or pleural infection was suspected. The vital signs were: Blood pressure 121/58 mmHg, pulse 145, respiratory rate 24, saturation 92% on room air, and temperature 39.1 °C. On physical examination, lung auscultation revealed reduced breath sounds and crackles at the right base.

Blood tests showed anemia (hemoglobin 4.5, considered unrelated to the infection), white blood count 17.2, thrombocytes 706, creatinine 43 µmol/L, normal bilirubin, and CRP 420 (**Table 1**). The arterial blood gas on room air revealed an acute respiratory alkalosis: PaO₂ 12.0 kPa, pH 7.51, PaCO₂ 4.1 kPa, and normal bicarbonate and lactate (**Table 1**).

Parameter	Value ¹	Reference interval
Blood tests		
Hemoglobin	4.5	7.3–9.5 mmol/L
White blood cell count	17.2	3.5–8.8 x 10E9/L
Lymphocytes	1.4	1.3–3.5 x 10E9/L
Neutrophils	14.9	2.0–7.0 x 10E9/L
Thrombocytes	706	145–390 x 10E9/L
Potassium	3.3	3.5–4.6 mmol/L
Sodium	135	137–145 mmol/L
Creatinine	43	45–90 µmol/L
eGFR	> 90	> 60 mL/min/1.73 m ²
Urea	4.4	2.6–6.4 mmol/L
Bilirubin	10.0	5–25 µmol/L
Glucose	5.5	2.9–8.3 mmol/L
CRP	420	mg/L
Arterial blood gas		
pH	7.51	7.35–7.45
PaO ₂	12.0	11.1–14.4 kPa
PaCO ₂	4.1	4.5–6.2 kPa
O ₂ saturation	0.99	0.95–0.99
Carbonmonoxyhemoglobin	0.02	< 0.02
Methemoglobin	0.01	< 0.02
Oxyhemoglobin	0.97	0.94–0.98
Bicarbonate (standard)	26	21–27 mmol/L
Base excess	2	–3–2 mmol/L
Lactate	1.2	0.5–1.6 mmol/L
O ₂ -flow	2.0	L/min

¹Values outside the reference interval are highlighted in bold.

Point-of-care lung ultrasound showed right-sided basal lung consolidation, and a simple pleural effusion that extended into the upper part of the right hemithorax (**Figure 1**).



Figure 1. Lung ultrasound image from the right basal lateral region showing a positive spine sign (visualization of the spine above the diaphragm), a simple pleural effusion without debris, septations, or loculations, and a lung consolidation.

An ultrasound-guided diagnostic thoracentesis was performed, yielding clear fluid with a pH of 7.15, indicating a high risk of pleural infection. Therefore, a small-bore chest tube (14F) was inserted under ultrasound guidance. Empirical treatment with cefuroxime and metronidazole was initiated, and the patient was transferred to a specialized ward for intrapleural saline flushing. Later, cultures identified *Fusobacterium necrophorum*. Subsequent CT of the neck and thorax showed no internal jugular thrombosis or septic pulmonary emboli. The patient was discharged one week later continued oral antibiotics, with outpatient follow-up.

Discussion

This case report illustrates four important clinical considerations for the ED physician:

First, the importance of a thorough medical history. Although the initial presentation was dominated by pulmonary findings, the preceding oropharyngeal symptoms provided an important clue to the underlying diagnosis of LS and helped guide subsequent evaluation and treatment.

Second, jugular vein thrombosis is not required in LS [2], but isolation of *Fusobacterium*, together with prior oropharyngeal and subsequent lung symptoms, should prompt CT of the neck to assess for thrombosis. Although anticoagulation remains controversial, it may be indicated in progressive thrombosis [3,4]. However, antibiotic therapy is still the cornerstone of treatment for both LS and pleural infection [4].

Third, point-of-care lung ultrasound rapidly identified a consolidation and pleural effusion and facilitated diagnostic thoracentesis.

PERSPECTIVES

1. Awareness of possible Lemierre's syndrome in patients with preceding sore throat, subsequent pulmonary symptoms, and either thrombosis of the internal jugular vein or isolation of *Fusobacterium necrophorum*.
2. The importance of medical history in acute visits.
3. The role of point-of-care ultrasound both as a diagnostic tool and in procedural guidance.

Fourth, when a pleural effusion is identified, the decision is whether diagnostic thoracentesis alone is sufficient or therapeutic thoracentesis is required for symptom relief. The choice should be based on the patient's clinical status and current guidelines for pleural infection, which emphasize that even a simple pleural effusion may represent an early stage of empyema and should not be considered uncomplicated based on its appearance alone [5].

In summary, this case highlights that LS should be considered in young, previously healthy patients with recent oropharyngeal symptoms who fail to improve as expected and subsequently develop systemic illness or lower respiratory tract involvement.

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WHAT DOES THE PAPER ADD?

Lemierre's syndrome may occur without thrombosis, but with identification of *Fusobacterium necrophorum* instead.

Conflicts of interest

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