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A critical care outreach team under strain – Evaluation of the service provided to patients with haematological malignancy during the Covid-19 pandemic

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ABSTRACT

Purpose: Critical Care Outreach Teams (CCOTs) have been associated with improved outcomes in patients with haematological malignancy (HM). This study aims to describe CCOT activation by patients with HM before and during the Covid-19 pandemic, assess any association with worse outcomes, and examine the psychological impact on the CCOT.

Materials and methods: A retrospective, mixed-methods analysis was performed in HM patients reviewed by the CCOT over a two-year period, 01 July 2019 to 31 May 2021.

Results: The CCOT increased in size during the surge period and reviewed 238 HM patients, less than in the pre- and post-surge periods. ICU admission in the baseline, surge and the non-surge periods were 41.7%, 10.4% and 47.9% respectively. ICU mortality was 22.5%, 0% and 21.7% for the same times. Time to review was significantly decreased ($p = 0.012$). Semi-structured interviews revealed four themes of psychological distress: 1) time-critical work; 2) non-evidence based therapies; 3) feelings of guilt; 4) increased decision-making responsibility.

Conclusions: Despite the increase in total hospital referrals, the number of patients with HM that were reviewed during the surge periods decreased, as did their ICU admission rate and mortality. The quality of care provided was not impaired, as reflected by the number of patients receiving bedside reviews and the shorter-than-pandemic response time.

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1. Introduction

Outcomes from haematological malignancy (HM) have improved rapidly due to advances in diagnosis, new therapies and enhanced supportive care in intensive care unit (ICU) [1-3]. Although the improvement in ICU outcomes is beginning to challenge the deep-seated pessimism around patients with HM, those who require multiple organ support (particularly invasive ventilation) are still associated with a higher mortality [4,5]. Early identification and surveillance of patients with HM at risk for deterioration, and their timely admission to ICU are essential, especially since suboptimal initial assessment on the ward and delayed admission have been associated with higher mortality [6,7].

Critical care outreach teams (CCOT) have been introduced into the UK National Health Service with the aim, among others, to avert inappropriate and ensure timely admission to ICU [8]. Their adoption has been associated with lower rates of in-hospital mortality and cardiac arrest,

lower rates of readmission to ICU and earlier treatment escalation planning [9]. Early CCOT involvement with deteriorating patients with HM on the ward has the potential to avert critical care admission by early recognition, prompt management and timely ICU admission of this at-risk patient population, using track and trigger systems such as the Early Warning Score [10]. Observational data suggest that in centres with established CCOTs, their involvement in patients with HM is significant and associated with improved outcomes [11-14]. Nonetheless, their actual impact on the outcomes has not been fully elucidated yet [15,16].

There is evidence that hospital capacity strain impacts on the decision to admit deteriorating patients to ICU [17] and has also been associated with poorer care when in ICU, such as reduced adherence to evidence-based prophylaxis for venous thromboembolism [18]; shorter time to establishing do-not-resuscitate status [19]; and, under certain circumstances but not always, worse clinical outcomes [20,21]. Furthermore, the unprecedented strain on ICU capacity during the Covid-19 pandemic had a detrimental effect on non-Covid services, with emerging evidence suggesting delays in presentation to hospital and higher in-hospital mortality [22-24]. Critical care staff worked in a sustained surge capacity, often above safe ICU occupancy, making difficult decisions, which often led to increased moral injury [25,26].

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The aims of this project were to describe the patterns of CCOT activation by patients with HM before and during the Covid-19 pandemic, assess whether the pandemic was associated with worse outcomes for critically ill patients with HM, and to examine the psychological experience of the CCOT during the same period. We hypothesised that increased strain on the CCOT would negatively impact CCOT performance, as well as the outcomes of patients with HM.

2. Materials and methods

The study hospital is a 950-bed tertiary referral centre in London, United Kingdom with a usual ICU capacity of 69 beds and no dedicated respiratory high dependency unit (HDU) prior to the pandemic. Its haematology department is a tertiary haemato-oncology centre with 60 inpatient hospital beds, performing approximately 90 allogeneic and 110 autologous transplants per year. The department is an international centre for research and the treatment of myeloid leukaemia, lymphoma and myeloma.

The hospital runs a CCOT as a seven-day, 24-h service, comprised of a team of two ICU-trained nurses, two registrar grade ICU doctors and a dedicated ICU consultant. Non-ICU specialties are not part of the CCOT. The team is activated either by direct referral from ward teams or by responding to an increased National Early Warning Score (NEWS; Table 1, online supplement). For NEWS >4 the ward medical team is asked to review the patient. If the NEWS is >6, the CCOT is alerted and reviews the patient either directly or remotely and offers a range of interventions from advice to transfer to critical care. NEWS is widely used in patients with haematological malignancy to identify early deterioration and its predictive value has recently been demonstrated [10].

We performed a retrospective, quantitative and qualitative data analysis (mixed-methods analysis) in patients with HM who were reviewed by the CCOT over a two-year period, 01 July 2019 to 31 May 2021. A list of eligible patients was generated using the CogStack platform at the study hospital. CogStack is an application framework that allows extraction of information from anonymised electronic clinical

text, such as the Electronic Clinical Records. Once extracted, the data are harmonised and processed [27]. Data extracted from the electronic health records system included: patient demographics and co-morbidity, haematological disease status, laboratory data and NEWS score at point of referral, interventions made by CCOT on the wards, intensive care admission, and patient outcomes.

The study was approved and registered as a Quality Improvement Project (project ID: KCC21112021CCO) by the Hospital's Service Evaluation Committee. The Research and Innovation Department waived the need for individual patient consent. The project was presented to the KERRI (King's Electronic Records Research Interface) Data Access Committee and gained approval for publication. The study did not receive specific grants from any funding agencies.

The study period was divided into two discrete phases: pre-pandemic, which ran from 01/06/19 to 28/02/20 and pandemic. The latter comprised of *surge 1* from 01/03/20–31/05/20; *non-surge 1*: 01/06/20–15/12/20; *surge 2* from 15/12/20–28/02/21; and *non-surge 2* which included 01/03/21–31/06/21. This classification was based on the duration our institution was under severe strain (ICU bed expansion >1.5 of baseline and CCOT in surge reconfiguration). We first conducted a univariate analysis to compare the baseline characteristics and outcomes for patients referred to the CCOT pre-pandemic vs during pandemic. Pandemic patients were further divided into surge and non-surge patients, and separately compared to the pre-pandemic period. To compare CCOT performance pre-pandemic vs during the pandemic, we compared time from CCOT referral to review and the type of review provided (bedside vs advice only). Student's *t*-test and Fisher's exact *t*-test were used for significance testing for continuous and categorical variables, respectively.

We compared hospital mortality for patients referred to the CCOT pre-pandemic and during the pandemic, and used a multivariate logistic regression analysis to control for patient baseline characteristics and clinical characteristics at the time of referral. Models were compared using chi-squared test. We also conducted a sensitivity analysis wherein we compared hospital mortality for patients referred to the CCOT pre-pandemic and during surge periods only.

Table 1
Baseline characteristics of patients with HM reviewed by the CCOT.

	Baseline (N = 104)	Surge (N = 40)	p-value	Non-surge (N = 94)	p-value
Gender					
Female	39 (37.5%)	20 (50.0%)	0.19	43 (45.7%)	0.25
Age (years)					
Mean (SD)	55.4 (14.1)	51.3 (13.8)	0.11	56.5 (13.4)	0.57
Diagnosis					
Acute lymphoblastic leukaemia	6 (5.8%)	4 (10.0%)	0.46	2 (2.1%)	0.29
Acute myeloid leukaemia	27 (26.0%)	4 (10.0%)	0.04	17 (18.1%)	0.23
Aplastic anaemia	5 (4.8%)	2 (5.0%)	1	1 (1.1%)	0.22
Chronic lymphocytic leukaemia	1 (1.0%)	2 (5.0%)	0.19	3 (3.2%)	0.35
Chronic myeloid leukaemia	2 (1.9%)	1 (2.5%)	1	3 (3.2%)	0.67
Multiple myeloma	11 (10.6%)	5 (12.5%)	0.77	19 (20.2%)	0.07
Myelodysplastic syndrome	13 (12.5%)	6 (15.0%)	0.78	7 (7.4%)	0.35
Non-Hodgkin's lymphoma	39 (37.5%)	16 (40.0%)	0.85	40 (42.6%)	0.56
Hodgkin's lymphoma	0 (0%)	0 (0%)	–	2 (2.1%)	–
Charlson Comorbidity Index					
Mean (SD)	3.64 (1.48)	3.43 (1.60)	0.45	3.76 (1.40)	0.59
Resuscitation Status					
For cardiopulmonary resuscitation	99 (95.2%)	38 (95.0%)	1	89 (94.7%)	1
Highest NEWS score on date of referral					
Mean (SD)	1.82 (1.60)	2.03 (2.11)	0.57	1.96 (2.19)	0.61
Haemoglobin on date of referral					
Mean (SD)	98.2 (20.9)	93.2 (22.0)	0.22	93.9 (18.9)	0.13
Serum creatinine on date of referral					
Mean (SD)	92.6 (46.7)	94.6 (51.3)	0.83	104 (108)	0.33
Platelet level on date of referral					
Mean (SD)	129 (119)	120 (93.9)	0.64	131 (121)	0.92
Neutrophils on date of referral					
Mean (SD)	4.99 (11.8)	6.14 (11.6)	0.6	5.55 (16.6)	0.78

CCOT: Critical Care Outreach Team; HM: haematological malignancy; NEWS: National Early Warning Score.

2.1. Qualitative analysis

In order to understand the subjective effect of the pandemic on CCOT staff, all nursing members of the outreach team were invited to participate in semi-structured interviews, led by members of the hospital's Clinical Ethics Committee. The psychological experience of the outreach nursing team was collected during three separate interviews and themes were generated using an inductive thematic analysis method [28]. The analysis followed six stages: 1) familiarizing oneself with the data; 2) generating initial codes; 3) searching for themes; 4) reviewing themes; 5) refining and naming themes; 6) producing a report. The themes referred to a word, concept or sentence which captured something important in relation to the research question, based on the researchers' judgment. Some qualitative researchers use pre-defined theoretical frameworks to structure their analysis, but our analysis started without preconceived ideas or an attempt to fit the data into a pre-existing framework. Thematic saturation was achieved across all themes constructed during the analysis, which meant that further data collection didn't further understanding in relation to what has already been gained. Discussion between the debriefing team took place at all stages of the analysis to confirm the interpretations of the qualitative data and ensure constructed themes accurately reflected the data set.

3. Results

At the start of the pandemic (and the study period), the CCOT almost doubled in size during the surge period, increasing to eleven members (ICU consultant, 4 registrar grade ICU doctors, 4 ICU nurses, 1 theatre practitioner and 1 runner). At the same time, overall ICU capacity was increased to 140 beds, with expansion to wards, operating theatre and recovery areas. The activity of the haematology department also varied significantly during the studied time periods. In March – end of May 2020 all but the most urgent transplants were suspended, which meant that effectively all myeloma autografts were paused and only with high-risk AML and ALL transplants were performed. Activity slowly built up from June 2020 and it officially paused again at the end of December 2020 until February 2021. Despite that, overall transplant activity was comparable with 88 allografts/ 119 autographs in 2019, 71 allografts/ 107 autographs in 2020 and 77 allografts/ 97 autographs in 2021.

A total of 352 patients were referred to the CCOT during the study period and 238 (54.8%) were reviewed by the service (the rest of the

referrals being involvement in arrest/ peri-arrest episodes and 'concern calls' that didn't result in a review). Of the patients reviewed, 172 were referred in the pre-pandemic period (7 calls/ week), 71 in the surge (3 calls/ week) and 191 (5 calls/ week) in the non-surge periods ($p = 0.01$). The total number of referrals received by the outreach team during the same time were >3260, with approximately 840 of the calls being placed during the pre-pandemic period (26 calls/ week), and 1650 and 790 of the calls made during the surge (75 calls/week) and non-surge (19 calls/ week) periods respectively. The patients' baseline characteristics are shown in Table 1. Their review profile and outcomes are shown in Table 2. The type of review, remote and bedside didn't differ between the pre-pandemic and pandemic (surge and non-surge combined) periods (Fig. 1). Time to review differed significantly between the same time periods, with the CCOT attending to haematology patients quicker than pre-pandemic ($p = 0.012$) (Fig. 2).

Of the reviewed patients with HM, 96/ 238 (40.3%) were admitted to ICU; 40 patients (41.7%) were admitted to ICU during the baseline period, 10 (10.4%) during the surge and 46 (47.9%) during the non-surge periods. No patient- or disease-related factors were associated with ICU admission (Table 2, online supplement). Seventy-one patients did not survive to hospital discharge (29.8%), and of those 19 were priorly admitted to ICU (19/96, 19.8%). Pre-pandemic ICU mortality was 22.5%, compared to 0% ($p = 0.17$) during surge period and 21.7% ($p = 0.1$) during the non-surge period. Similarly, pre-pandemic hospital mortality was 31.7% compared to 27.5% ($p = 0.69$) and 28.7% ($p = 0.76$) during surge and non-surge periods respectively. After accounting for patient baseline and clinical characteristics in a logistic regression model, there was no difference in hospital mortality for patients with HM referred to CCOT when we compared (i) pre-pandemic vs during pandemic referrals ($p = 0.40$) or (ii) pre-pandemic vs surge referrals only ($p = 0.41$) (table 3, online supplement).

The responses of the nurses' interviews were labelled using descriptive and in vivo codes. The codes describing similar contents were grouped together, reviewed, and recorded, if necessary, to be collated and visualize emergence of themes. The findings were organized in four themes:

3.1. The overwhelming nature of the time-critical work

Both surges of the pandemic resulted in a sudden, exponential increase of patients with respiratory failure that exceeded standard ICU capacity. The volume of patients with critical hypoxia, as well as the

Table 2
CCOT review profile and outcomes of HM patients.

	Pre-pandemic (N = 104)	Surge (N = 40)	p-value	Non-surge (N = 94)	p-value
Type of review n(%)					
Bedside	63 (60.6%)	24 (60.0%)	1	58 (61.7%)	0.54
Remote	37 (35.6%)	13 (32.5%)		28 (29.8%)	
Missing	4 (3.8%)	3 (7.5%)		8 (8.5%)	
Time to bedside review (mins)					
Mean (SD)	22.0 (25.3)	14.5 (17.2)		13.8 (14.9)	
Missing	41 (39.4%)	16 (40.0%)		36 (38.3%)	
Admitted to ICU n(%)					
Y	44 (42.3%)	19 (47.5%)	0.57	33 (35.1%)	0.38
N	60 (57.7%)	21 (52.5%)		61 (64.9%)	
ICU Outcome n(%)*					
Alive	31 (77.5%)	10 (100%)	0.17	36 (78.3%)	1
Dead	9 (22.5%)	0 (0.0%)		10 (21.7%)	
Hospital LOS (days)					
Mean (SD)	29.0 (23.1)	41.5 (55.8)		39.3 (32.1)	
Hospital Outcome n(%)					
Alive	71 (68.3%)	29 (72.5%)	0.69	67 (71.3%)	0.76
Dead	33 (31.7%)	11 (27.5%)		27 (28.7%)	
* patients admitted in ICU (N)	40	10		46	

CCOT: Critical Care Outreach Team; HM: haematological malignancy.

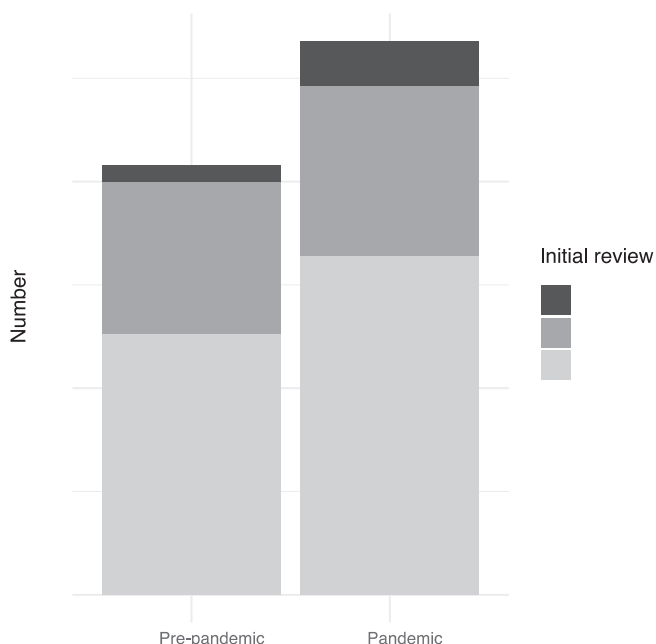


Fig. 1. Type of CCOT review pre- and during the pandemic. CCOT: Critical Care Outreach Team.

intensity of their management created a strained environment, with staff frequently feeling overwhelmed and unable to cope with the job pressures.

*'[...] it was relentless... they kept coming and coming and the phone never stopped ringing'.
'... and at some point I thought: this is it, we will not make it...'*

The number and rapidity of patient deterioration during both pandemic surges, and the fact that critical care beds were not readily available exacerbated the strain experienced by CCOT staff, who often felt 'snowed under'. Interestingly, working under pressure also highlighted positive emotions towards other members of the CCOT; compassion, care and kindness were emotions often mentioned by the interviewees.

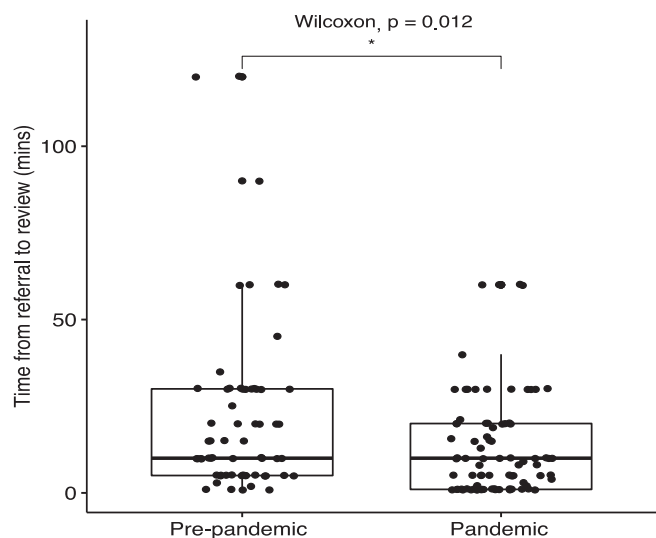


Fig. 2. Time to CCOT pre- and during the pandemic.

3.2. The uncertainty of administering therapies where evidence was lacking

Members of the CCOT spoke about the pressure they felt when asked to facilitate the administration or continuation of therapies at the request of colleagues, when the likely benefit was unclear. This was particularly difficult when the patients were distressed or unable to consent.

'It felt like we were unable to make up our minds. The patient was dying but [the parent team] continued to administer drugs that didn't seem to make any difference. Sometimes it felt like torture.'

The sense of pressure sprung also from patient/ family requests for therapies that were not evidence based. Even though the CCOT were not the primary therapy decision-makers, having to 'deny' patients medication that the latter thought beneficial weighed heavy on their minds.

*'The number of times I was asked for hydroxychloroquine... It is so hard to say that the hospital won't be providing this treatment. The families were so angry – sad and angry'.
'... a wife was asking me why her husband wasn't going to ICU. What was I supposed to say? I called the doctors to speak to her...'*

3.3. Feelings of guilt from having insufficient time to deliver care

The increased number of referrals to the CCOT during the surge periods created feelings of inadequacy and frustration at not having the time to provide the quality of care that the CCOT members expected of themselves. The high mortality witnessed, especially during the first surge, resulted in feelings of sadness and disappointment that the dying patients couldn't receive more holistic end-of-life care.

'Sometimes, I took care of two or three patients that died in one shift. It felt like I was going from one dying patient to another... they all died alone. [I] found that really, really hard.'

The interviewees also reported anxiety that some patients were looked after by redeployed staff with no ICU experience. The anxiety frequently turned into frustration when staff that the CCOT provided training for during the first surge were not allocated to Covid wards during the second surge.

3.4. The increased decision-making responsibility

Several nursing members of the CCOT commented on what they perceived as the burden of decision-making responsibility:

'Patients were coming in the emergency department and decisions needed to be made urgently... sometimes the patients couldn't give you any information but still you needed to decide. Thankfully, colleagues came to help but still... [it was] difficult.'

Although the triage decisions were more difficult for the medical members of the CCOT, the nurses commented on the difficulty they encountered when decisions to limit life-sustaining treatment were challenged by the parent teams or by families. The limited time to reach a decision, due to rapid physiological deterioration, heightened the feelings of uncertainty and doubt of the CCOT.

4. Discussion

The Covid-19 pandemic has created a significant mismatch between ICU supply (in the form of beds, staff and/or other resources) and demand (the need for admission and management of critically ill

patients). Even before the pandemic, high ICU capacity strain had been associated not only with increased hospital mortality [20,29] but also with lower chance of admission to ICU [17], poor quality of care and adverse psychological sequelae for ICU healthcare professionals [30,31]. Emerging literature suggests that the deleterious effect of the SARS-CoV-2 infection on patients with HM is extenuated [32,33]. However, no study to date has explored the impact of the pandemic on the management of deteriorating HM patients, *prior* to their admission to ICU. We have described the significant expansion of the CCOT in our institution, which consisted of doubling of its staffing, in order to respond to the doubling in referral rate during the surge periods. We have shown a decrease in CCOT bedside and remote reviews of patients with HM during the two surge periods, which was at odds with the staggering increase in referrals for other hospitalised patients. Furthermore, despite the increased demand on the CCOT, there was no statistical difference between the types of reviews offered to haematology patients, whereas the response time improved.

Several studies have reported on the collateral damage of the Covid-19 pandemic on the non-Covid patient population [23,34,35]. The present study was an attempt to assess whether the strain put on our CCOT translated into lapses in the provided quality of care, using response time and ICU admission as surrogate markers. The results suggest that, even during the surge period, the CCOT attended to the deteriorating HM patients faster than before the pandemic (22 \pm 25 min vs. 14.5 \pm 17 min), without changing the mode of care delivery (bedside vs. remote). This of course is very reassuring but needs to be interpreted with caution. In the height of the pandemic, the haematopoietic stem cell transplantation (HSCT) services in our institution (and indeed the country) were paused, with all but the more urgent cases being admitted. This undoubtedly would have impacted on the number of patients referred to the CCOT, as is demonstrated by the decrease in the number of HM referrals during the surge period. Nonetheless, and in the context of the tripling of the total referrals to the CCOT, the prompt response time probably highlights the high-quality service provided to patients with HM after the expansion of the CCOT.

Critical care admission of HM patients during the Covid-19 pandemic has been reported between 18 and 21% of hospitalised patients [32,33]. On the contrary, we reported rates that fluctuated from 10% during the capacity surges, to >40% in the pre-pandemic and non-surge periods. Although detailed data on the exact reason for admission is not available, almost all critically ill patients, that required ICU admission during the two surge periods, had a SARS-CoV-2 diagnosis. The significant lower admission rate compared to international data can be explained by a change in treatment escalation planning (TEP) and patient selection upstream of the decision to admit to ICU. Capacity strain has been found to modify TEP practices and expedite end-of-life discussions both in the emergency department [36] and in ICU [19]. In an international survey of ICU staff caring for Covid-19 patients, at different stages of the pandemic up to one third of responders reported that limits were placed on administering mechanical ventilation, and more than half reported changes to policies and practices for cardiopulmonary resuscitation [37]. In a previous study conducted at our institution, the ICU admission rate for patients with HM was found to be approximately 47% [14], a proportion that was similar to the pre-pandemic period and at which we returned, as soon as the high ICU strain subsided and HM activity approached its baseline (non-surge periods).

In a multinational project aimed to collect Covid-19 cases occurring in HM patients, an overall mortality of 31% was reported [32]. In a systematic review of cancer patients with Covid-19 admitted to ICU, pooled mortality was approximately 60%, with HM being associated with significantly higher mortality compared with non-haematologic cancers [38]. The present study demonstrated an ICU mortality of approximately 23% and 22% for the pre-pandemic and non-surge periods respectively. These results are comparable to previous findings from the same institution [14] but also the international literature [4,39]. On

the contrary, no HM patient admitted in ICU during the surge periods died. This surprising result may be attributed to the confounding effect of upstream patient selection, which was suspected but cannot be confirmed with the present data. In a recent study on the outcome of cancer patients considered for ICU admission, a high denial rate was associated with lower mortality [6]. As mentioned previously, the extreme pressure for ICU beds during the surge periods modified TEP practices in critically ill patients [37] and it could be postulated that only patients with the highest chance to survive ICU were admitted.

Individuals that worked on the front line during this pandemic were affected in a multitude of ways, as they were trying to cope with the increased workload and fear of the disease, whilst making difficult decisions around escalation of treatment [40]. A large number have suffered psychological distress, moral injury and mental exhaustion [41,42]. A common reported theme was being unable to complete tasks adequately or provide a standard of care seen as essential prior to the pandemic, which appeared more prevalent in more senior staff [43]. Senior staff members also described the psychological impact of supporting other team members, describing a sense of 'taking on others' psychological distress [43]. The present study reinforces the above themes, with feelings of guilt and overwhelming responsibility being commonly reported. Even though the CCOT includes medical staff, they work in a rotational pattern, minimising the exposure to the potential stressors. The stable workforce who consists of senior ex-ICU nurses, are all highly trained clinicians used to performing at a high level. The shift from holistic, optimal review and management to providing emergency care ('firefighting') may be the reason of the reported feelings of inadequacy and frustration, which were not justified either by process or patient outcomes.

Our study has several important limitations: first, its retrospective, observational nature precludes any inferred causality, especially a CCOT constitutes a complex intervention, with potential confounding factors that have not been explored fully. Second, due to the extreme pressures on CCOT during the pandemic, prioritisation was given to the clinical workload. This resulted in a significant amount of missing data, especially on the CCOT's performance measured (e.g. time to review), as well as on the characteristics of the HM patients reviewed (e.g. HSCT vs chemotherapy). Last, this is a single centre study with a robust CCOT that had experience in the review and management of HM patients outside ICU before the pandemic. It is possible the reported results cannot be replicated in different healthcare systems, where an outreach team was created as a result of the capacity surge of the pandemic. Nonetheless, this is the first study to describe the adaptation of the CCOT during the surge period of the Covid-19 pandemic and assess its impact on patients with HM upstream of ICU admission.

5. Conclusions

Despite the increase in total hospital referrals of patients with HM, less of them were reviewed by the CCOT during the surge periods. The quality of care provided by the CCOT wasn't impaired, as reflected by the number of patients receiving bedside reviews and the shorter-than-pre-pandemic response time. Patient outcomes, ICU admission rate and mortality, appeared improved both in the surge and non-surge periods. Sources of anxiety for the nursing members of the CCOT were the overwhelming clinical work and the increased decision-making responsibility of the role, as well as the insufficient time to deliver optimal care, which resulted to feelings of guilt. The impact of hospital admission policies and available treatments for HM patients during the surge periods of the pandemic should be explored further.

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None.

CRedit authorship contribution statement

Emma Prower: Conceptualization, Writing – original draft, Writing – review & editing. **Sophie Hadfield:** Conceptualization, Writing – review & editing. **Rohit Saha:** Data curation, Formal analysis, Writing – review & editing. **Timothy Woo:** Data curation. **Kar Mun Ang:** Data curation. **Victoria Metaxa:** Visualization, Conceptualization, Writing – review & editing.

Declaration of Competing Interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jccr.2022.154109>.

References

- Jurcic JG. Highlights in hematologic malignancy treatments: leukemia, myelodysplastic syndromes, and allotransplant—new drugs on the horizon for acute myeloid leukemia. *JAMA Oncol.* 2017;3(3):299–300.
- Pulte D, Jansen L, Castro FA, Brenner H. Changes in the survival of older patients with hematologic malignancies in the early 21st century. *Cancer.* 2016;122(13):2031–40.
- Azoulay E, Schellongowski P, Darmon M, Bauer PR, Benoit D, Depuydt P, et al. The intensive care medicine research agenda on critically ill oncology and hematology patients. *Intensive Care Med.* 2017;43(9):1366–82.
- Azoulay E, Pickkers P, Soares M, Perner A, Rello J, Bauer PR, et al. Acute hypoxemic respiratory failure in immunocompromised patients: the Efraim multinational prospective cohort study. *Intensive Care Med.* 2017;43(12):1808–19.
- Azoulay E, Lemiale V, Mokart D, Pène F, Kouatchet A, Perez P, et al. Acute respiratory distress syndrome in patients with malignancies. *Intensive Care Med.* 2014;40(8):1106–14.
- van der Zee EN, Benoit DD, Hazenbroek M, Bakker J, Kompanje EJO, Kusadasi N, et al. Outcome of cancer patients considered for intensive care unit admission in two university hospitals in the Netherlands: the danger of delayed ICU admissions and off-hour triage decisions. *Ann Intensive Care.* 2021;11(1):125.
- Mokart D, Lambert J, Schnell D, Fouché L, Rabbat A, Kouatchet A, et al. Delayed intensive care unit admission is associated with increased mortality in patients with cancer with acute respiratory failure. *Leuk Lymphoma.* 2013;54(8):1724–9.
- Department of Health, editor. *Comprehensive critical care: A review of adult critical care services*. In: Department of Health, ed. London; 2000.
- Maharaj R, Raffaele I, Wendon J. Rapid response systems: a systematic review and meta-analysis. *Crit Care.* 2015;19(1):254.
- Constantinescu C, Pasca S, Iluta S, Gafencu G, Santa M, Jitaru C, et al. The predictive role of modified early warning score in 174 hematological patients at the point of transfer to the intensive care unit. *J Clin Med.* 2021;10(20):4766.
- Bokhari SWI, Munir T, Memon S, Byrne JL, Russell NH, Beed M. Impact of critical care reconfiguration and track-and-trigger outreach team intervention on outcomes of haematology patients requiring intensive care admission. *Ann Hematol.* 2010;89(5):505–12.
- Hayani O, Al-Beihany A, Zarychanski R, Chou A, Kharaba A, Baxter A, et al. Impact of critical care outreach on hematopoietic stem cell transplant recipients: a cohort study. *Bone Marrow Transplant.* 2011;46(8):1138–44.
- Pattison N, Ashley S, Farquhar-Smith P, Roskelly L, O'Gara G. Thirty-day mortality in critical care outreach patients with cancer: an investigative study of predictive factors related to outreach referral episodes. *Resuscitation.* 2010;81(12):1670–5.
- Taheri L, Anandanadesan R, de Lavallade H, Pagkalidou E, Pagliuca A, Mufti G, et al. The role of a critical care outreach service in the management of patients with haematological malignancy. *J Intensive Care Soc.* 2019;20(4):327–34.
- Gershkovich B, Fernando SM, Herritt B, Castellucci LA, Rochweg B, Munshi L, et al. Outcomes of hospitalized hematologic oncology patients receiving rapid response system activation for acute deterioration. *Crit Care.* 2019;23(1):286.
- Civantos B, Añón JM, Yus S, Asensio MJ, García-de-Lorenzo A. Outcomes of hospitalized hematologic oncology patients receiving rapid response system activation for acute deterioration: another time, another way. *Crit Care.* 2019;23(1):419.
- Anesi GL, Chowdhury M, Small DS, Delgado MK, Kohn R, Bayes B, et al. Association of a Novel Index of hospital capacity strain with admission to intensive care units. *Ann Am Thorac Soc.* 2020;17(11):1440–7.
- Weissman GE, Gabler NB, Brown SE, Halpern SD. Intensive care unit capacity strain and adherence to prophylaxis guidelines. *J Crit Care.* 2015;30(6):1303–9.
- Hua M, Halpern SD, Gabler NB, Wunsch H. Effect of ICU strain on timing of limitations in life-sustaining therapy and on death. *Intensive Care Med.* 2016;42(6):987–94.
- Gabler NB, Ratcliffe SJ, Wagner J, Asch DA, Rubenfeld GD, Angus DC, et al. Mortality among patients admitted to strained intensive care units. *Am J Respir Crit Care Med.* 2013;188(7):800–6.
- Anesi GL, Kerlin MP. The impact of resource limitations on care delivery and outcomes: routine variation, the coronavirus disease 2019 pandemic, and persistent shortage. *Curr Opin Crit Care.* 2021;27(5):513–9.
- Bhatia R, Sylaja PN, Srivastava MVP, Komakula S, Iype T, Parthasarathy R, et al. Clinical profile and outcome of non-COVID strokes during pandemic and the pre-pandemic period: COVID-stroke study group (CSSG) India. *J Neurol Sci.* 2021;428:117583.
- Ball J, Nehme Z, Bernard S, Stub D, Stephenson M, Smith K. Collateral damage: hidden impact of the COVID-19 pandemic on the out-of-hospital cardiac arrest system-of-care. *Resuscitation.* 2020;156:157–63.
- Kovach CP, Perman SM. Impact of the COVID-19 pandemic on cardiac arrest systems of care. *Curr Opin Crit Care.* 2021;27(3):239–45.
- Burman R, Cairns R, Canestrini S, Elias R, Metaxa V, Owen G, et al. Making ordinary decisions in extraordinary times. *Bmj.* 2020;370:m3268.
- Cabarkapa S, Nadjidai SE, Murgier J, Ng CH. The psychological impact of COVID-19 and other viral epidemics on frontline healthcare workers and ways to address it: a rapid systematic review. *Brain Behav Immun Health.* 2020;8:100144.
- Jackson R, Kartoglu I, Stringer C, Gorrell G, Roberts A, Song X, et al. CogStack - experiences of deploying integrated information retrieval and extraction services in a large National Health Service Foundation Trust hospital. *BMC Med Inform Decis Mak.* 2018;18(1):47.
- Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol.* 2006;3(2):77–101.
- Wilcox ME, Harrison DA, Patel A, Rowan KM. Higher ICU capacity strain is associated with increased acute mortality in closed ICUs. *Crit Care Med.* 2020;48(5):709–16.
- Opgenorth D, Stelfox HT, Gilfoyle E, Gibney RTN, Meier M, Boucher P, et al. Perspectives on strained intensive care unit capacity: a survey of critical care professionals. *PLoS One.* 2018;13(8):e0201524.
- Bagshaw SM, Opgenorth D, Potestio M, Hastings SE, Hepp SL, Gilfoyle E, et al. Healthcare provider perceptions of causes and consequences of ICU capacity strain in a large publicly funded integrated health region: a qualitative study. *Crit Care Med.* 2017;45(4):e347–e56.
- Pagano L, Salmanton-García J, Marchesi F, Busca A, Corradini P, Hoenigl M, et al. COVID-19 infection in adult patients with hematological malignancies: a European Hematology Association survey (EPICOVIDEHA). *J Hematol Oncol.* 2021;14(1):168.
- Vijenthira A, Gong IY, Fox TA, Booth S, Cook G, Fattizzo B, et al. Outcomes of patients with hematologic malignancies and COVID-19: a systematic review and meta-analysis of 3377 patients. *Blood.* 2020;136(25):2881–92.
- Santi L, Golinelli D, Tampieri A, Farina G, Greco M, Rosa S, et al. Non-COVID-19 patients in times of pandemic: emergency department visits, hospitalizations and cause-specific mortality in northern Italy. *PLoS One.* 2021;16(3):e0248995.
- Golinelli D, Sanmarchi F, Capodici A, Gribaudo G, Altini M, Rosa S, et al. Variations of the quality of care during the COVID-19 pandemic affected the mortality rate of non-COVID-19 patients with hip fracture. *PLoS One.* 2022;17(2):e0263944.
- Mathews KS, Durst MS, Vargas-Torres C, Olson AD, Mazumdar M, Richardson LD. Effect of emergency department and ICU occupancy on admission decisions and outcomes for critically ill patients. *Crit Care Med.* 2018;46(5):720–7.
- Wahlster S, Sharma M, Lewis AK, Patel PV, Hartog CS, Jannotta G, et al. The coronavirus disease 2019 pandemic's effect on critical care resources and health-care providers: a global survey. *Chest.* 2021;159(2):619–33.
- Nadkarni AR, Vijayakumaran SC, Gupta S, Divatia JV. Mortality in cancer patients with COVID-19 who are admitted to an ICU or who have severe COVID-19: a systematic review and meta-analysis. *JCO Glob Oncol.* 2021;7:1286–305.
- Azoulay E, Mokart D, Pène F, Lambert J, Kouatchet A, Mayaux J, et al. Outcomes of critically ill patients with hematologic malignancies: prospective multicenter data from France and Belgium—a groupe de recherche respiratoire en réanimation onco-hématologique study. *J Clin Oncol.* 2013;31(22):2810–8.
- Mehta S, Machado F, Kwizera A, Papazian L, Moss M, Azoulay É, et al. COVID-19: a heavy toll on health-care workers. *Lancet Respir Med.* 2021;9(3):226–8.
- Muller AE, Hafstad EV, Himmels JPW, Smedslund G, Flottorp S, Stensland S, et al. The mental health impact of the covid-19 pandemic on healthcare workers, and interventions to help them: a rapid systematic review. *Psychiatry Res.* 2020;293:113441.
- Pappa S, Ntella V, Giannakas T, Giannakoulis VG, Papoutsis E, Katsaounou P. Prevalence of depression, anxiety, and insomnia among healthcare workers during the COVID-19 pandemic: a systematic review and meta-analysis. *Brain Behav Immun.* 2020;88:901–7.
- Grailey K, Lound A, Brett S. Lived experiences of healthcare workers on the front line during the COVID-19 pandemic: a qualitative interview study. *BMJ Open.* 2021;11(12):e053680.