# Out-of-Hours Hospital Service: A Multi-Phased Approach to Applying a Systems Analysis

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#### ABSTRACT

Healthcare needs to provide services 24 hours a day, seven days a week, 365 days a year. This includes out-of-hours from 17:00 to 09:00 weekdays, weekends and Bank Holidays. To provide this care, which has been estimated to be about 75% of the working week, dedicated out-of-hours teams have developed within the healthcare system. At one large NHS Hospital Trust, the focus of this study, the out-of-hours care is provided by the Hospital 24 service, a small team with limited resources covering a wide range of medical and surgical specialities across two large and complex hospital sites. In light of the increasing demand on this service, changes in available technology and with the numerous changes as a result of the COVID-19 pandemic, the Out-of-Hours Review aims to capture the current state of this service to determine the potential requirements for the future. This component of the Out-of-Hours Review aims to provide a high-level description of the system elements of the Hospital 24 Service. The systems analysis was compiled from three different data sources, namely a survey, data from the task management system and observation sessions. Using the SEIPS 2.0 model, high-level descriptions of the different work system components and a preliminary list of the barriers staff encounter, and facilitators staff use in this work system were generated. This analysis also identified the perspectives, system components and interactions that need to be explored in more detail in the next phase of this review.

## **KEYWORDS**

Healthcare, Out-of-Hours, Systems Analysis

#### Introduction

In healthcare, care needs to be provided 24 hours a day, seven days a week, 365 days a year. To achieve this, different working time arrangements have emerged. The working time arrangements can be broadly divided into in-hours, which is the care provided Monday to Friday between 09:00 and 17:00, and out-of-hours (Blakey et al., 2012), from 17:00 to 09:00 weekdays, weekends and Bank Holidays (Perez et al., 2016). To maintain a well-functioning healthcare system, appropriate out-of-hours (OOH) care is essential (Huibers, Giesen, Wensing, & Grol, 2009) and is provided in both primary and secondary care settings. For the secondary care setting, it has been estimated that 75% of the working week in hospitals is covered by OOH, with this care being mostly provided by a small skeleton team with few resources over a wide range of specialities usually across large and complex sites (Brown et al., 2013; Brown, Shaw, Sharples, Jeune, & Blakey, 2015; Martindale et al., 2019).

To provide OOH care, the Hospital at Night model, a UK wide project was initiated in August 2004 (Mahon, Harris, Tyrer, & Health, 2005). This model proposed redefining the medical cover for work during the night and over weekends by deploying co-ordinated teams to improve efficiency in

resource management and allow more time for medical staff to engage in clinical activity (Blakey et al., 2012; Fernandes & Raptis, 2008). This model was created in response to the European Working Time Directive (Mahon et al., 2005), which is an initiative to prevent employers from requiring their staff to work excessively long hours due to the implications for staff health and safety. The Hospital at Night model differs from previous models in that the team is a single multidisciplinary team providing cover across the whole hospital, whereas previously specialty-specific staff were working individually (Fernandes & Raptis, 2008), and variations of site shift-based cover and the traditional on-call cover were provided (Beckett et al., 2009). The exact composition of these teams varies between hospitals due to the composition and volume of workload as well as local policy (Blakey et al., 2012).

At the Hospital Trust that was the focus of this study, OOH care was initially provided by the Hospital at Night teams, which is now known as the Hospital 24 service. Since the implementation of this service in 2006 (Blakey et al., 2012), this service has not been reviewed at this Trust. In light of the increasing demand on this service, changes in available technology and especially with the numerous changes to the healthcare work system since the start of the COVID-19 pandemic, the OOH Review aims to capture the current state of this service to determine the potential staffing and work system requirements for this service in the future. The work described in this paper formed a component of the Human Factors workstream that together with the Demand and Capacity and Benchmarking workstreams forms the OOH Review at this Trust. The aim of this analysis was to provide a high-level depiction of the system elements of the OOH Service that impact work within the Hospital 24 service. The purpose of this was to compile a preliminary system description of the Human Factors workstream. Furthermore, this initial analysis aimed to describe how data from the different workstreams of this project (e.g. Demand and Capacity workstream) could be integrated to provide a description of the work system components of this service.

## Method

Three different data sources were included to generate this system analysis. The first data set was the amalgamated results from a staff survey conducted in September 2020 that formed part of a collaborative review of Hospital 24 teamworking and processes conducted by the Improvement and Transformation team. The second data set were data extracts from the online task management system, Nervecentre, compiled by the Demand and Capacity workstream. Nervecentre is a software product that is used within over 40 NHS Trusts across the UK (Nervecentre Software Ltd., 2021). This data set included a list of all tasks raised through Hospital 24 for the OOH service using Nervecentre from December 2020 to 18<sup>th</sup> June 2021. The third data set was four observation sessions of registrars working with the Hospital 24 service during August 2021. The observations were undertaken as part of a collaboration between the Demand and Capacity workstream and the Human Factors workstream. Additional information for each data source has been include in Table 1.

Although these data sources were analysed for different workstreams, the amalgamated survey results and the data extracts from Nervecentre were re-analysed from a Human Factors perspective. Each data source was analyzed using the Systems Engineering Initiative for Patient Safety (SEIPS) 2.0 model (Holden et al., 2013). This model provides a structure for the study of work done by healthcare professionals (Holden et al., 2013) and consists of work system components, processes and outcomes (Carayon et al., 2014). The work system components consist of the person (including staff, patients and their families), tasks, tools and technologies, the internal environment, the organisational conditions and the external environment (Carayon et al., 2014; Holden et al., 2013). The information from the different data sources were grouped into the different components described in the model and then the results from the different data sources were compiled to

generate a high-level systems description. The barriers and facilitators identified in the different data sources were compiled and mapped to the different work system components as described by the SEIPS 2.0 model.

Data Source	Description	Contribution to results
Hospital at Night	Amalgamated results from 89 responses.	Work systems overview
Survey (September 2020)	All the respondents were junior doctors.	Barriers and Facilitators
Data extracts from	A list of all the tasks raised through Hospital 24	Work systems overview
Nervecentre	since December 2020 until 18 June 2021	– Tasks
	including the frequency of each task.	<ul> <li>Tools and Technology</li> </ul>
Observation Sessions – August 2021	<ul> <li>A total of 4 observation sessions were done with registrars working on the Hospital 24 service during August 2021. The observations were completed at the following times:</li> <li>Twilight shifts: 16:30 – 20:30 (23/08/21, Site 1), 16:00 – 21:00 (19/08/21, Site 2)</li> <li>Night shifts: 20:00 – 02:00 (26/08/21, Site 2), 02:30 – 08:30 (19/08/21, Site 1)</li> </ul>	<ul> <li>Work systems overview <ul> <li>Organisation of work</li> <li>Tasks</li> </ul> </li> <li>Barriers and Facilitators</li> </ul>

Table 1: The data sources used in the systems analysis for the Hospital 24 work system.

# Results

The results will first describe the Hospital 24 work system and the individual work system components on the SEIPS 2.0 model. Following this, the barriers and facilitators identified from the data will be described.

# Hospital 24 - Systems Description

The different data sources were used to identify elements for five of the six work system components described by the SEIPS 2.0 model. No information was found in the data for the external environment component of the SEIPS 2.0 model. For the person component of the SEIPS model, as the Hospital 24 service adopts a multidisciplinary and multispecialty approach, this results in a variety of different staff being involved in this work system, which adopts a different structure to other work systems within healthcare (i.e. departments, wards). The core Hospital 24 team consists of a medical consultant head of service, general manager, matron, nurse manager, deputy nurse managers as well as deputy lead consultants. In addition to this, the core team also includes nurse coordinators, clinical support workers (CSWs), safety fellows and acute response fellows. The doctors that support OOH work through Hospital 24 are drawn from four different divisions (Medicine, Surgery, Cancer Associated Specialties, Family Health - Gynaecology) and therefore come from various specialities. Although they form part of the larger Hospital 24 team, they are not line managed by Hospital 24. The doctors supporting Hospital 24 also have a wide range of experience levels and are from a variety of grades including junior grades (Foundation doctors) to the more senior members including registrars and consultants. In addition to the staff that deliver the Hospital 24 service, there are also the staff that refer or request support from this team, the staff on the wards where the extended Hospital 24 team come into contact to complete the requested tasks and provide care, as well as the patient and their family. The interaction with the patient and their family with the registrar on duty for the Hospital 24 shift (occasionally in person or on the phone) was identified in the observation data.

A variety of tasks form part of the OOH system that the Hospital 24 service completes and are necessary to support the functioning of the hospital. Four main categories of tasks could be identified. These included work scheduling tasks, emergency and clinical tasks, communication and collaborative tasks, as well as administrative and other tasks. Examples of the types of tasks included in each of the four main categories have been listed in Table 2. These align with the study by Martindale (2019), which identified ten types of coordination decisions that are essential for the effective performance in OOH care. **Error! Reference source not found.** also includes the ten types of coordination decisions identified in the study by Martindale and colleagues (2019), grouped according to the task categories identified in this study .

Table 2: Examples and the four main categories of tasks for the Hospital 24 work system and their alignment with the ten types of coordination decisions identified by Martindale and colleagues (2019).

Task Categories	Examples of tasks identified across the data sources	Categories by Martindale et al., 2019
Work scheduling tasks	Scheduling staff across shifts, scheduling staff for the shift, coordinating and managing resources, filtering tasks, task assignment, task prioritisation (both at a team and individual level)	<ul> <li>Managing workload</li> <li>Evaluating tasks</li> <li>Organising staff</li> </ul>
Emergency and clinical tasks	Emergency and clinical response, diagnostic tasks, response to Early Warning Scores, clinical tasks, prescription and reviewing tasks	<ul><li>Attending to the patient</li><li>Responding to the alert</li></ul>
Communication and collaborative tasks	Department collaboration, communication with patient and their family, interaction with patient, information exchange, information seeking and transfer, handover	<ul> <li>Identifying if help and support was required</li> <li>Gathering information</li> <li>Communicating information</li> <li>Handing over the task</li> </ul>
Administrative and other tasks	Clerking, data entry, documentation, troubleshooting	Following routine

The data extracts from Nervecentre, compiled by the Demand and Capacity workstream, and the results from the four observation sessions of registrars working the Hospital 24 service during August 2021, both yielded more detailed information on tasks, with each source providing information on different types of tasks. An important note is that Nervecentre data captures workas-disclosed and work-as-measured, and the observations were able to capture work-as-observed. Although by using a variety of different data sources, one can come closer to understanding workas-done, one needs to acknowledge the limitations of the different forms of work one has captured and that ultimately there may be additional work that is still 'invisible'. The Nervecentre data provided a list of the tasks, a total of 53 tasks, which align with the three of the four main task categories described above. None of the tasks listed from Nervecentre were associated with the main task category of work scheduling. The task type that had the highest total number of recorded tasks was cannulation or venepuncture tasks at 36 991 over 7-month period (17% of all the tasks documented in Nervecentre). In addition to the tasks described by the data from Nervecentre, the observations of the registrars generated a list of additional tasks that are performed as part of this work system. Examples of additional task types identified in the observation data included data entry, documentation, patient interaction, communication information exchange, information seeking, information transfer, and troubleshooting.

The tools and technology in this work system, in addition to the tools and technology needed for clinical work, include online software, aggregated scoring systems, devices to access these

programs as well as the more traditional tools such as pens and papers. The key online software system identified was Nervecentre, the aggregated scoring systems included NEWS2 and sepsis scores, and the devices included pagers, computers and phones. Nervecentre is a task management system that not only allows for tasks to be requested, but also acts as an information source and is used by some as a communication and handover tool. Furthermore, as the tasks for the extended Hospital 24 team are requested, assigned and managed through Nervecentre, this online system is also being used to determine current workload. NEWS2 scores, which are determined within the Nervecentre program, is a separate tool and is the latest version of the National Early Warning Score (NEWS). The six physiological parameters used to determine this score include respiration rate, oxygen saturation, systolic blood pressure, pulse rate, level of consciousness or new confusion and temperature (Royal College of Physicians, 2017). The importance and need for devices to access online systems and for communication is highlighted in this work system due to the distribution of the team and extensive geographical layout that constitutes the internal environment for this system.

Two key divisions in the organisation of work can be identified in the results, namely within the Hospital 24 service and the second within the larger healthcare system. The organisation of work within the Hospital 24 service includes organisation and teamwork of the core team and the extended team as described in the persons component of this analysis. This refers to the structure and work between the OOH core team, extended team and the cardiac arrest team. This also includes the communication that occurs between these teams, the members within the team and communication with senior staff that are part of the Hospital 24 service. The communication would be to escalate tasks, information retrieval regarding clinical queries, seeking advice from senior staff and with coordinators regarding task priority. Another key organisation of work element for this division is the distribution of workload across the Hospital 24 team. The second division is the organisation of work in connection with the other systems within this healthcare system. This includes access to policies (e.g. local policy on the NEWS2 tool), communication with wards to triage requests and cross team work between Hospital 24 staff and ward staff. Additionally, this work system component also includes the effect the different specialties have on workload, the additional workload that may be generated directly from the wards (which would not be captured by Nervecentre) and the accumulative effect of scheduling of staff to OOH shifts across the month which is done by staff outside of the Hospital 24 service.

For the internal environment element of the Hospital 24 work system, this takes a more nontraditional form as staff will work across the hospital site during the Hospital 24 shifts, and therefore the internal environment will be dictated by the different wards they visit during their shift. Furthermore, the different areas or specialties and therefore the different wards, will be associated with different workloads. For example, a COVID ward will result in different workloads compared to a Health Care of Older Persons ward. The location of the wards will also affect workload for staff, as this will have an impact on the distance staff need to travel between task requests. The distribution of the Hospital 24 team (both core and extended teams) across the hospital sites will influence the need for technology to communicate and one's ability to locate staff.

# **Barriers and Facilitators**

The barriers and facilitators identified for the Hospital 24 service were predominantly extracted from the Hospital at Night Survey (September 2020) completed by junior doctors. A couple of additional barriers and facilitators were also identified in the observation data. Six types of barriers and six types of facilitators were identified. The six barrier types identified in the data included challenges as a result of the distributed team and work environment, the effect of the workload,

limited or incomplete information, a limited understanding of staff roles and responsibilities, IT barriers and other challenges.

The barriers and challenges that originate as a result of the distribution of this work system (internal environment) included a lack of senior staff availability, lack of clarity regarding who is in the team and their roles and responsibilities, limited team support, communication problems and handover challenges. Barriers that arose as a result of the workload include that junior staff felt unsupported, staff felt that due to the high workload this made prioritising their own task list challenging, and that the online system provides an inaccurate perception of the workload. Additional barriers that were associated with the workload included the tasks that came directly from ward staff thereby increasing the unacknowledged workload, that the different specialities come inherently with different workloads which may not be recognised and as a result of the workload some staff felt unable to take breaks. Barriers associated with limited or incomplete information included insufficient information to filter and prioritise different tasks including responding to NEWS2 scores, unclear escalation plans for patients, missing recent observations, callers did not have all the required information - so a call back was needed, and unsure of where to find information about local policies. Challenges associated with a limited understanding of staff roles and responsibilities included staff being unaware of the coordinators' role and skills and staff being allocated tasks they felt were not their responsibility. Examples of IT barriers included functional limitations of the Nervecentre app or software, variations in how the Nervecentre software is used, connection and access problems, limited training and experience with the software, slow IT equipment, and the need to use multiple other online systems to locate information. Other barriers included junior staff being more reluctant to help out with unfamiliar specialties, tasks being assigned a more urgent label than is necessary, inappropriate escalation of NEWS2 scores, the effect of scheduling staff on back-to-back days and staff not knowing where they will be assigned prior to the shift.

Six types of facilitators were identified. These included improving communication, using the team as a resource, enhancing teamwork both across the Hospital 24 team and with wards, enhancing the use of Nervecentre, creating a formalised approach for redistributing staff according to work pressures and providing information on the internal environment so more junior staff know where things are. Examples of how to improve communication include enhancing and formalising the handover for Hospital 24 staff, using the SBAR technique to communicate information and feeding back to the coordination team regarding change in task duration so they can assist with additional resources if needed. Examples of enhancing teamwork included knowing who is in the team, meeting up of the team during the shift and a diagrammatic representation of the team. Examples of enhancing the app to set and protect staff breaks, trying to capture a better understanding of why staff abort or reject tasks and using it as a communication tool.

## Discussion

This systems analysis generated a high-level systems description which provides a macroscopic view of this work system. As the OOH care is provided by a small team (Brown et al., 2015), work is structured and managed quite differently than during the in-hours of the working day. To support this small team and allow for the management of tasks from a variety of different wards, the software tool Nervecentre plays a key role in this work system. The documented tasks within Nervecentre align with the findings from a study by Perez and colleagues (2016) that found out of over 40 different types of task requests, with the most frequent including cannulations, drug prescriptions, clinical reviews and management or blood results interpretation. However, as highlighted in the description of the work system and several barriers, this task management system does not capture all the tasks that are part of this system. This has important implications for the application of data from this online tool, especially with regards to determining workload. By using

multiple data sources, a more complete picture of tasks performed by the Hospital 24 service could be determined. The observation sessions also provided insight into some of the emergent coordination behaviours the literature reports for this type of work system, namely pre-emption, information augmentation and self-organisation (Martindale et al., 2019). These behaviours are adaptations that staff in this system employ to manage the functions of OOH care and maintain control. Pre-emption describes the emergent behaviour of addressing tasks that might never make it onto the formal task list, and can be described as the 'invisible work' done by the Hospital 24 team (Martindale et al., 2019; Suchman, 1995). An example of pre-emption includes the ward passing information and a task directly to a Hospital 24 clinician when they appear on a ward for another task, which they decide to complete then. Although no reference was found for the SEIPS 2.0 model element of the external environment across the different data sources, a known external environment element that contributed to the OOH work system, identified in the literature, was the effect of the European Working Time Directive (Mahon et al., 2005). This resulted in the initiation of the Hospital at Night model, now known as Hospital 24, that provides the care during the OOH service.

## **Conclusion and Next Steps**

This high-level systems analysis compiled from three different data sources provides a depiction of the system elements, barriers and facilitators for the Hospital 24 service that impacts work. A key consideration and limitation of these results, associated with the initial aim of this phase of the project, is that as it was a preliminary and high-level systems analysis, not all essential perspectives of this work system have been represented in this analysis. The data sources provide information on different perspectives of the work system and therefore the results are limited to the perspectives represented in the data sources included. This initial analysis aimed to compile a preliminary systems description, identify which perspectives still need to be considered and identify which system components and interactions require further analysis. This will be undertaken by the next phase of the Human Factors workstream (October 2021 – January 2022). The areas, as described by the SEIPS 2.0 model, that need further exploration include:

- The People in the System:
  - The staff and teams that refer into Hospital 24
  - The role of the coordinator. This would include other work system elements and interactions for this role (e.g. tasks, teams and staff interaction, organisation of work)
  - And ensure representation of all essential roles for the Hospital 24 service in the systems description
- Tasks, Tools and Technology Interaction:
  - Expanding the understanding of the work system of tasks recorded by Nervecentre
  - Capturing more detail on "invisible" work
- People and Organisation of Work Interaction: Identify the teams that interact with Hospital 24 and generate team descriptions
- Outcomes:
  - Patient and Organisational Outcomes: exploration of incident reports to identify work system elements, processes and outcomes associated with the Hospital 24 service.

The expansion of these work system elements will be compiled using a variety of data sources, different to those included in this initial analysis. Data sources to be included are incident reports, interviews with different staff groups, and additional observation sessions.

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