European Agency for Safety and Health at Work

Automation of cognitive and physical tasks in the health and social care sector: implications for safety and health

Summary

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1 Introduction and objectives

This study[1] provides an overview of the state of play and the occupational safety and health (OSH) implications related to the use of artificial intelligence (AI) and robotics for the automation of physical and cognitive tasks in the health and social care (HeSCare) sector. The technologies in the scope of the study are AI-based systems as well as complex non-AI based robotic systems according to the taxonomy developed by the European Agency for Safety and Health at Work (EU-OSHA, 2022). The geographical scope is the EU-27 with examples from outside the EU if relevant (e.g. from leading countries in robotics such as Japan, South Korea and the United States). The study covers the state of play and research from the last five years to ensure that the information is up to date with the latest technological, economic and social developments.

2 Methodological approach

A literature review was conducted following a systematic approach including academic articles published in peer-reviewed journals, as well as complementary desk 'grey' research. A search string was used combining keywords referring to AI and robotics, to OSH implications and to the HeSCare sector. A total of 570 sources were screened from academic databases, of which 531 were discarded after review and full text assessment. Additionally, 189 sources were identified via desk research, of which 50 were discarded after full text assessment. In total, 178 sources were included in the literature review. Based on the insights of the literature review, a preliminary selection of 10 examples of automated or automatable tasks was made, of which five were then selected as good practice examples. Further desk research was conducted to retrieve information on OSH implications, workers' experience, and barriers to and drivers of implementation of those technologies. A total of 54 additional sources were identified to provide further information on the selected examples.

3 The HeSCare sector and related OSH risks

The HeSCare sector in Europe is key in providing and promoting health and wellbeing for European citizens and communities, including its workforce. **The importance of the HeSCare sector is likely to further increase** because of the rising demand for care services driven by an ageing population coupled with longer life expectancy. In parallel, the upward trend on the demand for healthcare labour will be confronted with a **shortage in healthcare workforce supply**. The shortage is expected to be exacerbated as the sector faces an ageing workforce, which is approaching retirement age (Cedefop, 2023). Additionally, in many European countries, the HeSCare sector is characterised by low levels of employee retention due to the challenging working conditions, difficulties in human resource management, high chronic fatigue, poor quality of care or lower work satisfaction (European Commission, 2023; Lavoie-Tremblay et al., 2022).

According to the European Survey of Enterprises on New and Emerging Risks (ESENER) (EU-OSHA, 2022a), **the main OSH risks faced by the HeSCare workforce are musculoskeletal (MSK) and psychosocial risks**. MSK risks may include regularly lifting patients, pushing heavy medical equipment, working in awkward positions, performing repetitive movements, and prolonged standing and sitting. These risks, which stem from the physically demanding nature of care work, create a significant concern due to their prevalence and the potential impact on the wellbeing of workers. Additionally, HeSCare workers commonly face several **psychosocial risks**, such as stress and associated burnout due to work intensity and the increasing workload. EU-OSHA identifies **biological**, **chemical and physical risks** as three other types of risk faced by HeSCare workers (EU-OSHA, 2022a).

The digitalisation of the sector, and specifically the automation of working tasks, is increasingly considered a significant factor in reducing OSH risks by providing solutions to strenuous tasks. However, the use of AI-based systems may also create new risks related to the fear of job loss, deskilling and lack of appropriate skills (Konle-Seidl & Danesi, 2022).

[1] The full report is available at: https://osha.europa.eu/en/publications/automation-cognitive-and-physical-tasks-health-and-social-care-sector-implications-safety-and-health

4 State of play of automation of tasks in the HeSCare sector

4.1 Automation of physical tasks

Advanced technologies are mainly used to perform person-related or object-related tasks. In particular, collaborative robots work alongside human workers to assist or substitute them in the performance of certain tasks. In most cases, the technology is used to assist professionals in performing tasks that are physically demanding.

4.1.1 Person-related tasks

Surgical robots have been developed for **minimally invasive interventions** such as laparoscopic procedures (Longmore et al., 2020). Surgical robots often consist of robotic arms that are controlled through a console by surgeons seated near the operation table. The robot is controlled by the surgeon using master controls that directly translate the surgeon's movements to the robot moving the instruments. Surgical robots can provide assistance to surgeons for the performance of certain surgical tasks such as tissue manipulation, to perform endoscope video positioning tasks, and tumour resection.

Recent robotic developments have also facilitated the **lifting and moving of patients**. Such robot lifting devices usually take two forms: either they are wearable devices such as exoskeletons that augment the weight that the healthcare worker can normally lift, or they take the form of robotic arms that help lift users (Wright, 2018). Another robotic application refers to **autonomous mobile robots** (AMRs) that can **transport patients** within healthcare facilities (Fragapane et al., 2020). Robotic applications have also been developed to substitute healthcare workers in the performance of routine tasks such as **sample collection** (e.g. blood samples) (Kaiser et al., 2021). Another development refers to **robotic-assisted therapy** by which robots are used to help patients perform their physical rehabilitation exercises (Li et al., 2021).

4.1.2 Object-related tasks

AMRs help in the **transportation of material** across hospital facilities such as medicine, (heavy) medical equipment and sterile instruments, and to deliver meals to patients (Fragapane et al., 2023; Holland et al., 2021). Another example of AMRs in hospital facilities refers to ultraviolet-based AMRs used to assist in the **disinfection and sterilisation of rooms** and equipment (Mehta et al., 2023).

AI systems have also been developed to replace nurses in performing **patient assistive routine tasks**. For instance, to **help feed meals to patients** who are unable to feed themselves (Kim et al., 2022). Pilot programmes are also being conducted to develop mobile robotic platforms that assist patients in fetching objects or for temperature measurement, as well as to support patients while they are using their walkers (Lundberg et al., 2022).

4.2 Automation of cognitive tasks

AI-based systems are mainly used to assist human workers in performing person- and information-related tasks. The majority of the technologies used to assist in information-related tasks can be grouped under the term of clinical decision-making support systems. In the case of the technology used in person-related tasks, the automation of tasks refers to the interaction with patients mainly via the use of chatbots or social robots.

4.2.1 Person-related tasks

Chatbots and conversational agents can be used to replace or assist healthcare professionals in their **communication activities with patients**, such as by providing basic information on treatment or by scheduling an appointment. Chatbots have also been used for therapy purposes such as automating the monitoring of symptoms, to coach individuals in times of emotional distress, and to provide therapeutic conversations with its users (Pham et al., 2022). Other robotic applications to assist in performing person-related tasks refer to **social robots** that have a human or pet-like form and aim at **providing companionship and emotional support** to patients. Social robots have been used to treat several mental disorders, educate patients on medical issues and to perform patient monitoring (Ragno et al., 2023).

4.2.2 Information-related tasks

A particular strand of research on the application of AI-based systems in the healthcare sector refers to the use of AI to guide clinicians' decision-making processes. In fact, the **use of AI to inform diagnosis** has a great potential as algorithms can interpret large numbers of medical images (i.e. X-rays, MRIs, computed tomography scans) by identifying patterns and anomalies that may be difficult for the human eye to detect (Oren et al., 2020). Yet, as **AI clinical decision-support systems** still have inaccuracies, they inform and assist clinicians in the diagnosis rather than automate doctors' diagnosis tasks. In this respect, such AI-based systems can augment the capabilities of clinicians by providing interpretative assistance (Yoon et al., 2023). AI-based systems assist clinicians in their decision-making process in several tasks, such as by recommending tailored treatment plans (Blanco-Gonzalez et al., 2023), or by supporting the triage of patients (Jiang et al., 2021). With regard to the latter, automated triage systems can assess the need for critical care and detect abnormal medical conditions or acute morbidity (Fernandes et al., 2020).

In addition, AI has enabled more sophisticated **remote patient monitoring systems**. Such systems automatically measure and collect data on patients' physiological parameters to identify and predict health risks the patient may be facing or likely to face in the near future (Shaik et al., 2023).

Another stream of AI applications to automate information-related tasks refer to those developed with the aim of **alleviating healthcare professionals' administrative burden**. A particular example refers to the **automation of medical reporting** using natural language processing (NLP) systems. Initial developments in the field were related to technologies that could **automatically extract clinically relevant information** from patient- and clinician-recorded dialogues (Rajkomar et al., 2019). Similarly, AI systems were found to alleviate the **administrative work burden** by, for instance, **automating the management of electronic health records**, where AI could help streamline the organisation of patient records, improve data accuracy and accessibility while reducing workloads (Honavar, 2020).

5 OSH implications in the automation of tasks

Whereas the automation of physical and cognitive tasks in the HeSCare sector presents several opportunities, significant OSH concerns may also arise from the adoption of these technologies. According to the EU-OSHA taxonomy (EU-OSHA, 2022b), OSH implications can relate to physical, psychosocial or organisational aspects. These technologies can be used for a wide range of applications, implying that sometimes the boundaries between some of these aspects are blurred.

5.1 Physical implications

MSK and physical risks

The automation of physical tasks has mainly been reported to **reduce physical fatigue and the incidence of MSK disorders** in the HeSCare workforce. For instance, a systematic review on the MSK impact of robotic-assisted surgery conducted in 2020 showed that robotics provided superior **MSK benefits** while reducing workload compared to laparoscopy procedures for both surgeons and trainees (Wee et al., 2020). However, surgeons **still experience considerable physical pain** and discomfort in their neck, shoulders and back (Patel et al., 2023). These issues were related to the **ergonomic design** of the surgeons' console controls (Hislop et al., 2023). Hence, whereas surgical robots have improved overall MSK health, more anthropometric tool design to adapt the tool to the workers' diversity of physical characteristics and features is needed to improve surgeons' experience.

The use of robots to assist in moving patients has been demonstrated to **reduce the physical burden of nurses and caregivers** (Persson et al., 2022). This is of particular importance as the lifting and moving of patients has been identified as the main contributor to lower back pain among nurses, which is the most common occupational health problem affecting them (Brinkmann et al., 2022). Similarly, the use of robotic applications to transport instruments and equipment provides hospital workers support in this task and reduces their physical workload.

On the other hand, as technological advances enable robots to **work alongside humans** instead of in delimited separate spaces such as cages, the **risk of collision with or harm** to the human worker could eventually increase. For this reason, robots include several embedded sensors to avoid any potential harm they could cause to humans.

Exposure to biological and chemical risks

Technological advances have helped improve the overall safety of HeSCare professionals. In general terms, the use of robotic applications helps **reduce the exposure to infectious diseases** such as COVID-19, HIV, hepatitis B and tuberculosis (Shen et al., 2022). A particular example of this reduced exposure refers to the use of robots to complement disinfection tasks. There is evidence that the use of such robots is very effective in reducing the number of bacteria remaining in manually disinfected rooms (Casini et al., 2023). Hence, the use of robots for disinfection in healthcare facilities **reduces the exposure of workers to bacteria** and related contagious diseases.

5.2 Psychosocial implications

Workload

AI technologies are regarded as crucial to help meet the demand for HeSCare services while guaranteeing the quality of care. In this respect, overall gains in productivity thanks to the introduction of the advanced technologies can **make the workload more bearable**, and thus reduce workers' stress and risk of burnout. Notably, by automating certain routine tasks, workers can benefit from a more structured workflow that can contribute to **reducing stress levels** and increasing job quality and satisfaction, thereby **promoting better mental and emotional wellbeing** among employees. On the other hand, the deployment of advanced technologies can also create new monotonous tasks such as setting up and configurating the parameters of the technologies. Yet, unlike in other sectors, the introduction of advanced technologies is not expected to intensify work but to make the intense workload more bearable for HeSCare professionals.

AI systems also offer a great opportunity to **alleviate some of the administrative burden** of healthcare professionals. In this manner, healthcare professionals **can 'spend more time on tasks that focus on the clinical context** of their patients and attending to their needs' (Hazarika, 2020, p. 2), improving overall job satisfaction and decreasing their risk of burnout. However, it is unclear whether HeSCare professionals will use this spare time for more rewarding tasks (Sauerbrei et al., 2023).

Mental workload

Professionals in the HeSCare sector often face significant mental overloads as they need to conduct a high number of tasks simultaneously, or due to the emotional demands inherent to the nature of the work. This may in turn affect their psychosocial state and lead to a higher number of operational errors. The use of automated systems can help reduce HeSCare professionals' mental workload. A particular example refers to the use of AI technologies to assist surgeons in taking decisions during operations, which has been proven to help reduce their stress levels (Kazemzadeh et al., 2023). Notably, studies have found that surgeons self-reported lower workload and mental effort in robotic-assisted surgeries than with conventional ones (Moore et al., 2015).

On the other hand, AI systems could also increase workers' mental workload as HeSCare staff need to **familiarise themselves with the technology** and learn how to interact with it. Cognitive workload has, in turn, been found in the literature to be related to increased **risk of burnout** (Ehrmann et al., 2022). This is in particular the case for workers who do not have the adequate skills or have not followed the appropriate training to make optimal use of the technologies. Mental workload could also increase as HeSCare professionals may need to undertake additional tasks related to **overseeing the automated systems**.

Trust

Trust is a crucial element to gain both HeSCare professionals and patients' acceptance of automated systems, which is fundamental to guarantee an efficient deployment. Trust is also associated with **automation bias** which is defined as the tendency to over rely on the technologies as human workers overvalue machine-provided information over manual information (EU-OSHA, 2022c). An **over-reliance on technology** can **increase the exposure to safety risks** as technology can occasionally malfunction (Grissinger, 2019) and result in accidents. Automation bias can also contribute to the **loss of certain skills** in the workforce. In particular, automation bias can compromise a **worker's capacity to identify and respond to critical situations** promptly, consequently jeopardising patient safety and overall workplace wellbeing.

Skills

Advances in AI in the HeSCare sector raise concerns about the **risk of deskilling** of the workforce. As technologies take over certain tasks, HeSCare professionals may lose the ability to perform those tasks. According to Aquino et al. (2023), in healthcare, deskilling may result in deterioration of clinical skills, **affecting decision-making** across various stages of the clinical pathway, with potential negative implications on patients' safety. However, AI-based systems still present inaccuracies and limitations, so they are expected to assist workers rather than fully replace them.

The deployment of advanced technologies also implies that workers will need to **learn a new set of skills** to take full advantage of the technologies. The initial lack of skills to interact with the automated systems may result in **higher stress levels** as workers do not know how to make use of them. In this respect, training programmes are pivotal to guarantee workers' acceptance of the technology.

Human interaction

The deployment of technologies may reduce the level of human interaction and human touch, which are fundamental aspects in the provision of HeSCare services. In this regard, some healthcare professionals have raised their concerns on the potential **dehumanisation of care**, with the related loss of human judgment and empathy in worker–patient interaction services (Morrow et al., 2023). HeSCare professionals acknowledge that interpersonal contact is pivotal in the provision of care, as patients need emotional support and encouraging words (Klebbe et al., 2022). The automation of care practices may entail that the care workers' responsibilities shift from actively assessing patient needs to responding to alerts and following machine-generated recommendations (EU-OSHA, 2022c).

At the same time, automated systems may also free up working time that healthcare professionals can use to develop more meaningful and empathetic relationships with their patients. However, there is no evidence that healthcare professionals use the spare time to increase engagement with their patients (Sauerbrei et al., 2023).

5.3 Organisational implications

As the deployment of AI-based and complex non-AI-based systems transform work practices, the transition to AI-enabled workflows requires careful attention to the potential impact on job roles and responsibilities, emphasising the importance of **providing adequate training and support for workers** to adapt to their evolving roles in the automated environment (Vrontis et al., 2022). In this regard, establishments should introduce timely training programmes to ensure that their workforce knows **how to manage these new technologies**. The lack of such training may lead to OSH risks such as **high stress levels**. Similarly, as technologies will introduce new roles and tasks, such as those related to the supervision of the AI-based system, it is important to guarantee that this will not represent an unbearable extra workload for HeSCare workers.

6 Relevant automated and automatable tasks in the HeSCare sector

A list of 10 relevant examples of automated or tasks with automation potential in the HeSCare sector was identified from the literature review conducted. Among the selected examples of automated and automatable tasks, five good practice examples were identified: three corresponding to the automation of physical tasks, and two to the automation of cognitive tasks. Evidence was found that the reported good practice examples improved working conditions in general, and were effective in promoting health, safety and efficiency in the workplace. Furthermore, there was a reduction in OSH risks for HeSCare professionals. The selected good practice examples also tackle some of the most critical OSH challenges of the HeSCare sector, namely the intense workload and significant administrative burden, as well as working conditions related to MSK disorders.

Table 1: List of relevant examples of automated tasks or tasks with automation potential

Task	Description	OSH implications	Task characteristics			Good practice
Tissue manipulation during surgery interventions	Surgical robots automate procedures such as closing incisions, suturing or tissue retraction.	Reduction in risk of contagion and reduced physical strain.	Person-related	Non-routine	Assistance	✓
Lifting and moving patients	Robotic assistive devices consisting either of robotic arms or exoskeletons help move patients.	Reduction in physical strain and related MSK disorders.	Person-related	Routine	Assistance	✓
Transport of sterile instruments	AMRs can adapt their path to transport instruments.	Reduction in risk of contagion and reduced physical strain.	Object-related	Routine	Substitution	✓
Blood sample collection	Automated collection of blood samples to help diagnose patients.	Reduced risk of contagion, alleviate workload.	Person-related	Routine	Assistance	
Post-stroke rehabilitation	Automated repetition of multiple exercises for rehabilitation.	Lower physical strain, lower stress levels.	Person-related	Non-routine	Substitution	
Triage of patients	AI-based software can classify the severity of patients in emergency departments.	Manage more efficiently influx of patients, makes workload more bearable reducing stress levels.	Information-related	Routine	Assistance	✓
Medical reporting (digital scribes)	Use of NLP systems to draft medical notes and reports.	Reduction in administrative burden which improves mental wellbeing.	Information-related	Routine	Assistance	✓
Diagnosis generation	AI-based tools support diagnosis by detecting image anomalies with high levels of accuracy.	Make workload more bearable which improves wellbeing at work.	Information-related	Non-routine	Assistance	
Remote patient monitoring	Automated collection and analysis of vital signs and other physiological parameters.	Reduced risk of contagion, alleviate workload.	Information-related	Routine	Substitution	
Detection of precancerous lesions	AI-based tool assessing images to identify cancerous lesions.	Improvement in diagnosis ability helps alleviate workload.	Information-related	Non-routine	Assistance	

7 Conclusions

Based on the review of literature on the current state of automation of tasks in the HeSCare sector, and the analysis of examples of automated tasks or tasks with the potential for automation, the comparative analysis of the main takeaways can be summarised as follows:

- **More bearable workload for HeSCare professionals:** advanced technologies were found to help HeSCare professionals be more productive, by treating more patients in a shorter amount of time. This improved their ability to manage increasing workloads, which had been associated with a growing number of burnout cases.
- **Significant reduction in MSK risks and exposure to biological and chemical risks:** as advanced technologies take over the performance of physically strenuous tasks related to repetitive and uncomfortable positions and movements, the incidence of MSK disorders was found to decrease considerably. Likewise, the automation of tasks also reduced professionals' exposure to contaminated areas and infectious diseases.
- **Supporting the job of HeSCare professionals rather than substituting them:** automation systems still present some limitations that require the involvement of HeSCare professionals. Hence, the output provided by the technologies is still monitored and checked by the professionals. This implies that HeSCare professionals will need to take over other tasks related to the supervision of the technology which might be considered as monotonous and burdensome. At the same time, these limitations imply that HeSCare professionals are not likely to incur automation bias by which they over rely on the output provided by the technology over their human judgement.
- **Concerns on the potential loss of human interaction:** as advanced technologies take over the performance of certain tasks, contact with the patient, which is of utmost importance in the HeSCare sector, is expected to be reduced. Moreover, while the technologies are expected to alleviate the workload of HeSCare professionals so they can dedicate more time to direct patient care, there is no evidence that workers will dedicate this time to this type of tasks.
- **Relevance of providing adequate training to professionals**: training is pivotal to guaranteeing that HeSCare professionals take full advantage of the technology, and to help them easily overcome the initial increase in mental workload as they learn how to interact with the technology. In the case of some already widespread technologies, such as surgical robots, several European-level associations have developed structured training programmes to facilitate a safe, healthy and efficient implementation across hospital facilities in different European locations.
- **Importance of involving HeSCare professionals in the design and deployment of the technologies:** the examples we provided showed instances where the design of the technology had not been optimally adapted to all types of physical attributes (e.g. height, glove size, etc.), which led to a higher number of complaints about physical pain. In other cases, HeSCare professionals' experience with the technology was directly dependent on whether they had been involved in determining the best configuration of the tool so they could take full advantage of it.
- **Building trust is pivotal for widespread deployment of automation systems:** trust can be enhanced if automated systems show high levels of accuracy, or if they include adequate explanations and monitoring systems to identify any inaccuracies. In this respect, algorithmic transparency plays a crucial role so professionals can understand the output provided by the AI-based systems. Additionally, the enforcement of data protection legislation (i.e. GDPR) is of utmost importance to guarantee the protection of patients and workers' data, and thus trust and acceptance.

Based on these findings, some recommendations to ensure adequate OSH when introducing AI-based systems and advanced robotics in the HeSCare sector have been formulated:

- **Establishment of design standards:** to guarantee proper use of the automated systems, on top of required safety features, considering MSK health factors such as user interface design and equipment ergonomics is helpful to minimise the incidence of physical strain and to ensure wider acceptance and use of the technology by HeSCare professionals. Furthermore, to ensure that HeSCare professionals make use of the technology, it is important to adapt the technology's features so as to assist the medical staff according to their needs. This is in particular the case as automated systems still present limitations, making monitoring by HeSCare professionals necessary.
- **Implementation of training programmes:** this should be done with the objective of guaranteeing proper use and maintenance of the automated system, while facilitating professionals' acceptance of the technology. Trainings should be developed involving all relevant stakeholders, and in particular HeSCare professionals. The training should also help workers be aware of the limitations as well as potential inherent biases in the systems. Similarly, the training programmes could be accompanied with a set of guidelines, such as those developed to guide HeSCare professionals in moving patients to avoid MSK risks.
- **Set up mechanisms for continuous monitoring of AI-based systems:** trust and acceptance of the technology by both HeSCare professionals and patients is important to guarantee its widespread use. In this respect, an optimal strategy relates to setting up a monitoring system to: (i) monitor the algorithm, and (ii) maintain human oversight of the output to avoid bias and errors. An adequate level of resources should be allocated to the optimal implementation of such monitoring systems.

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