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RECENT DEVELOPMENTS

Semi-Automated Care: Video-Algorithmic Patient Monitoring and Surveillance in Care Settings

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Introduction

A recent addition to technologically enabled practices in healthcare that create new ethical and legal issues is "video-algorithmic patient monitoring." We use this term to describe an assemblage of video sensors and algorithmic software that enable nurses to make remote, non-contact clinical observations of patients in hospital environments. Terminology remains unsettled for this practice, as it often does in areas of rapid technological change. Other definitions include "artificial intelligence-enabled audio-visual surveillance and monitoring" (McDonald 2021), "vision-based patient monitoring and management" (Lloyd-Jukes et al. 2021) and "digitally assisted nursing observations" (Barrera et al. 2020). Video-algorithmic patient monitoring has been trialled in several countries on specific patient populations including on "renal patients undergoing dialysis, neonates in intensive care, adults in intensive care, and patients and staff in a high-security mental health setting" (Barrera et al. 2020). The technology is also being used by care services for older persons and persons with disabilities, including those with mental health conditions (McDonald 2021) and will be likely used in home-based care, particularly for older persons (Lange and Maruthappu 2019) if indeed this is not already occurring.

For the purposes of this commentary, we will focus on video-algorithmic patient monitoring in acute psychiatric settings, where it is at experimental stages (Barrera et al. 2020). Novel ethical and legal issues arise in the mental health context, particularly as semi-automated nursing may seek to analyse patient *behaviour*, such as those associated with self-harm, assault, and suicide, and not just physiological matters such as pulse and breathing rates. The behavioural component potentially shades into "surveillance," where "surveillance" is defined as comprising a "[w]atch or guard kept over a person … ; often … supervision; less commonly, supervision for the purpose of direction or control, superintendence" (Oxford English Dictionary 2018). This is also the case where monitoring extends to surveilling against staff malpractice (see Lloyd-Jukes et al. 2021). Further, a significant proportion of inpatients in acute mental health settings are detained and treated involuntarily (over 50 per cent in some acute public mental health systems), which carry the associated and vexed questions of upholding free and informed patient consent.

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Regardless of these specificities, the ethical and legal issues raised by video-algorithmic patient monitoring in psychiatric settings are relevant beyond the mental health context and concern potential futures of healthcare and human care more broadly.

Distributing "Nurse Monitoring" Across Different Human and Technical Actors

In acute psychiatric units, patients are routinely monitored in their bedrooms by nurses. Digitally-enabled "observation" would occur where patients' rooms are fitted with a camera and sensors that monitor the person's body using "computer vision, signal processing and [artificial intelligence] techniques to [remotely and continuously] track micromovements and colour changes" (Barrera et al. 2020, 37). A person's pulse and breathing rate can be detected by the sensors from several metres away and efforts are underway, as previously noted, to detect behaviours (Lloyd-Jukes et al. 2021). One primary aim is to reduce iatrogenic sleep disruption because nurses would no longer need to enter patients' rooms to make night-time clinical observations (Barrera et al. 2020). Reducing iatrogenic sleep disruption is intended to improve sleep quality, promote mental health recovery, and improve patients' overall experience of inpatient mental healthcare. Another aim is to reduce the human labour involved in typical nursing observation.

There are limited empirical studies of video algorithmic patient monitoring in psychiatric settings, making it difficult to weigh goals against risks. In England, Alvaro Barrera and colleagues (2020) conducted a "qualitative and preliminary" trial (the "Oxehealth Trial") on the use of "digital assisted observations" at the Vaughan Thomas psychiatric ward, at the Oxford Health Foundation Trust. The monitoring was used by nurses to take fifteen-minutely and hourly night-time clinical observations of patients in six individual bedrooms over a four-month period (Barrera et al. 2020, 36). The "Oxehealth sensors" used by researchers were wall-mounted video cameras along with "computer vision, signal processing and AI software" that enabled nurses to track their patients' locations and movements ("physical monitoring") and to record their heart and respiratory rates ("physiological" or "vital sign monitoring") (Lloyd-Jukes et al. 2021, 37–39). Both physical and physiological monitoring were achieved without the need for patients to wear on-body sensors (Barrera et al. 2020, 34–36). Infrared cameras allowed night-time operation of the system in low light (Lloyd-Jukes et al. 2021, 39). Software that was based on a computer-vision algorithm, analysed the video feed of patient movements. According to the study authors, this assemblage can be used to identify "indices relevant to the care of the patient, for example, the patient's level of agitation" as well as instances in which "the patient finds themselves in high-risk locations" (for example, standing at the edge of a bed), creating signals to which nurses could respond (Barrera et al. 2020, 37). A video feed of the patient's room could be reviewed live or in retrospect to help nurses and others to evaluate and respond to incidents (Lloyd-Jukes et al. 2021).

The Oxehealth system uses a further physical monitoring algorithm to generate a long-term "report" in the form of "a timeline summarising the patient's location (in bed, elsewhere in their room, etc) for a day or a week … to help characterise the patient's behaviour during that time interval" (Lloyd-Jukes et al. 2021, 37–38). Physiological monitoring using the Oxehealth system allows nurses to access "real-time spot measurements of pulse rate and breathing rate without them having to enter the room" (Lloyd-Jukes et al. 2021, 38). These measurements are "displayed on a screen in the nursing station or on hand-held tablet computers" (Lloyd-Jukes et al. 2021, 39).

The Utilitarian Calculus

Those wishing to undertake a cost-benefit analysis can glean potential risks and benefits from the small number of technical and applied studies on video algorithmic patient monitoring and surveillance (Barrera et al. 2020; Lloyd-Jukes et al. 2021), as well as research on the use of CCTV in health settings more generally (see eg, Appenzeller et al. 2019). CCTV and video algorithmic monitoring and surveillance have important points of overlap and difference, as we will discuss shortly.

Risks with video-algorithmic patient monitoring technology include the following:

- Forms of "video surveillance" may be themselves disturbing to patients;

- Patient well-being may be adversely affected, including worsened feelings of fear, distrust, delusions, and paranoid thoughts;
- It may contribute to "an atmosphere of detachment, control and fear";
- The intervention carries uncertain implications for patient consent and "function creep" (e.g. initially used to raise an alarm about respiratory failures but later used to surveil staff);
- Negative impact on privacy and dignity;
- Compromised data protection when recording and storing patient data;
- Potential use as a pretext to cut down on nurse labour and therefore diminish quality of care;
- Increase workload of healthcare workers concerning data-input, training, and system management, maintenance, and oversight, which may divert institutional resources and care labour away from face-to-face care.

Potential benefits of this technology include:

- Having the same level or higher levels of clinical accuracy and patient safety as traditional nursing observations (Lloyd-Jukes et al. 2021);
- Reduced sleep disruption for patients compared to traditional night-time nursing observations (Lloyd-Jukes et al. 2021; Appenzeller et al. 2019; Desai 2009);
- Improved sleep quality, mental health recovery, and patient experience of inpatient mental healthcare (Barrera et al. 2020);
- Better privacy and dignity of patients by avoiding intrusive night-time checks (Appenzeller et al. 2019);
- Improving staff safety by reducing verbal and physical aggression towards staff that may arise from intrusive night-time checks (Barrera et al. 2020);
- Reducing staff workload: allows observations to be done in less time (Barrera et al. 2020).

CCTV, Biometrics, and Law

The nature of the "monitoring" and how it is conceptualized is of crucial significance to ethical and legal frameworks. Video-based monitoring has hitherto been regulated primarily in relation to CCTV. Yet, video algorithmic patient monitoring carries important functional and technical differences, even though the differences are not always as clear as might be hoped.

Like CCTV, both *live and recorded video-feed display* are available to be viewed and reviewed respectively by nurses using a monitoring arrangement like the Oxehealth system. According to Hugh Lloyd-Jukes and colleagues (2021, 39), the ability to view a live video-feed of "the patient in their bed" while monitoring breathing and pulse rate, allows the Oxehealth system to "remotely transform […] the delivery of healthcare in these settings." They note that the system is:

> … designed to avoid the staff needing to view video feeds from rooms for extended periods of time (as would be the case if a CCTV system were installed). Instead, the use of identifiable video feeds by staff is restricted to brief observations or checks prompted by alerts. (Lloyd-Jukes et al. 2021, 43)

It is not clear how this restriction on the use of identifiable video feeds takes place, though it appears that decisions by nurses on "when to observe" are guided by the clinical judgement of the treating healthcare professionals with regard to a patient's care plan (Lloyd-Jukes et al. 2021, 39, 43). This approach appears to leave considerable discretion with hospital staff. As Lloyd-Jukes states: "[t]he frequency of observations is specified in the patient's care plan, but the nurses also exercise clinical judgment, and concern about a patient may lead them to record an extra set of observations *at any time*" (Lloyd-Jukes et al. 2021, 39, emphasis added).

Access to a live or recorded video feed of patient bedrooms for the purposes of clinical observation raise many of the same privacy and therapeutic concerns as with the use of plain CCTV surveillance (see generally Appenzeller et al. 2019). Lloyd-Jukes and colleagues also indicate that recorded video footage can be used in "investigations" after-the-fact to provide "objective evidence" for reviewing incidents involving patients; for example, determining the cause of a fall and if the patient experienced a head strike (Lloyd-Jukes et al. 2021, 39). Another example given was the video monitoring being used to investigate allegations of staff misconduct made by patients (Lloyd-Jukes et al. 2021, 39), a function

for which "surveillance" would be a more accurate characterization.

The regulation of video-based monitoring is presently centred on CCTV, although the rising use of biometric monitoring technologies more broadly is generating much law reform activity and legal scholarship (see for example, Kak 2020). In the mental health context, the use of CCTV would typically engage law that regulates mental health settings and authorizes involuntary psychiatric interventions (for example, mental health legislation) as well as laws concerning privacy, surveillance devices, and health records, among others. For example, in Victoria, Australia, the Chief Psychiatrist has established a guideline on "Surveillance and privacy in designated mental health services" ("the Guideline") under the terms of the *Mental Health Act 2014* (Vic) and with reference to the *Surveillance Devices Act 1999* (Vic), *Health Records Act 2001*), and the *Charter of Human Rights and Responsibilities Act 2006* (Vic) (Department of Health & Human Services 2018).

The Guideline recommends *against* the use of CCTV for "therapeutic observation." The Guideline states that "CCTV *must not* reduce the therapeutic interaction between staff and patients" (emphasis added) or "be used as an alternative to direct and active clinical observation by staff as this may have a negative impact on therapeutic rapport and infringe on a patient's right to privacy" (Department of Health & Human Services 2018, 7). Further, "Therapeutic observation … cannot ever be conducted from behind a barrier or via CCTV" (Department of Health & Human Services 2018, 7). "Therapeutic observation" is defined as "the purposeful gathering of information from people receiving care to inform clinical decision making and supported decision making by patients" (Department of Health & Human Services 2018, 7).

This strong note of disapproval would appear, by way of analogy, to implicate the use of digital sensor technology for night-time observations. If the video algorithmic monitoring is determined to have "a negative impact on therapeutic rapport" or to set up "a barrier" between nurse and patients, or "infringe on a patient's right to privacy," then the Guideline denunciation of CCTV for therapeutic purposes could carry across to this technology. On the other hand, if digital sensor technology is to be used only overnight when most patients would be trying to sleep, rather than during the day, that could alleviate some of concerns about the negative impacts on therapeutic rapport. These concerns might be further addressed if patients' consent and preferences for the use of this technology are actively sought (Appenzeller et al. 2019, 484). The Oxehealth study, for example, emphasized the need to train staff in communication with patients about the monitoring to meet standards of informed consent.

Regarding privacy, there are at least two considerations: whether the use of this technology could potentially expose patients to unwanted observation during "private activities" (Barrera et al. 2020, 37) and whether there are appropriate safeguards for patient data that are collected and stored (raising questions concerning the law of health records, privacy, data protection, and so on) (Appenzeller et al. 2019). If implementation did proceed, these considerations would need to be addressed with appropriate protocols, staff training, functional limits to what the technology can do, and so on.

Importantly, developers, hospital management, nursing staff need *not necessarily* incorporate video monitoring function into video algorithmic patient monitoring. For example, Ansgar Lange and Ben Maruthappu (2019) describe wall-mounted motion and pressure sensors and microphones in home-care arrangements for older persons that do not recognize personal visual characteristics as per typical camera technology. In their words, this functional alteration makes it "much less invasive than other high-definition technologies such as cameras" (Lange and Maruthappu 2019, ¶5). As an example, a naked person would have the same signals generated by the sensors, such as breath rate or changes to gait, as if they were dressed. Instead, according to Lange and Maruthappu (2019), the monitoring assemblage (sensors, microphone, software, and so on) can be used to "learn an individual's daily routine, make recommendations so that carers can enhance care plans, and alert caregivers and medical personnel to possible deteriorations in a person's health (such as changes in gait) or emergency situations (such as a fall)" (¶6). Setting aside conceptual and terminological questions about what constitutes "invasiveness" regarding the use of biometric monitoring, this example highlights the potential limits of CCTV guidelines and accompanying legislation, for resolving ethical and legal uncertainties. It also highlights how *design features* and *the service context in which they are used*

matter greatly both for enunciating ethical and legal concerns but also in matters with social and political significance, including public and patient views on benefit and harm.

Service User and Patient Input

Whatever ethical lens is used to assess video algorithmic patient monitoring—for example, an ethics of care emphasis on the risk of depersonalizing therapeutic relationships, or a classic health ethics framework to weigh harms and benefits—there is no avoiding the importance of input by those with first-hand experience as patients in acute psychiatric settings. This participatory ethos is increasingly considered standard practice in mental health-related policy and practice (World Health Organization 2021). According to Dainius Pūras, the former UN Special Rapporteur on the Right to the Highest Quality Physical and Mental Health:

> … participation of persons with mental health conditions, including persons with disabilities, in the planning, monitoring and evaluation of services, in system strengthening and in research, is now more widely recognized as a way to improve the quality, accessibility and availability of services and the strengthening of mental health systems. (Human Rights Council 2020, ¶13)

From a pragmatic perspective, the involvement of patients, service users, families and carers, and their representative groups, is generally agreed to increase the likelihood of "viable and effective—rather than disruptive and short-lived—advances" in digital technologies in the mental health context (Bhugra et al. 2017). Participatory methods also align with human rights standards to actively involve persons with disabilities in decisions about the law, policy, and programming that concerns them (United Nations Convention on the Rights of Persons with Disabilities, 2006, Preamble 15).

Deliberative, participatory development is also important because the convergence of medicine and technology tends to emerge from a concentration of power in a myriad of ways: venture capital and "Big Technology" companies, universities with large-scale infrastructure for technology development, government health agencies, professional associations, private hospitals, and so on. To ensure greater equity in design, development, and regulation, Adrian Guta, Jijian Voronka, and Marilou Gagnon (2018, 64) call for "interdisciplinary empirical research on the implications of these technologies that centers the experiences and knowledge of those who will be most affected".

Indeed, the Oxehealth trial involved a "patient and public involvement" research phase, which elicited concerns about patient safety, privacy, and the impact on staffing levels (Barrera et al. 2020). Patient and relative views on the digital sensors themselves were not reported. However their feedback indicated that they found traditional observations "loud," "disturbing," "disconcerting," "intrusive and demoralizing," and questioned their therapeutic value (Barrera et al. 2020), which raises questions about the desirability of the nurse monitoring in their current form.

Conclusion

The arrival of algorithmic video patient monitoring and surveillance will raise pressing questions in the mental health context but also in the health and social care context more broadly. These discussions will necessarily occur within a wider public debate about biometric technology and society, and the type of futures involving biometrics that are presently being imagined. Current legal and regulatory responses to video monitoring tend to be centred on CCTV, which is a limited frame that will become more so as technological capacities blend amid an increasingly complex communication ecosystem. Careful attention to the design features and service context in which any such monitoring is being proposed will be crucial to satisfactorily addressing major ethical and legal questions. Finally, the consequences of poorly designed data-driven technologies to assist people in mental health crises will be borne by people who are engaging with mental health services or who face mental health interventions. Hence, these individuals and groups must be actively involved in any governance of algorithmic and data-driven technology in the mental health context, including asking fundamental questions such as whether algorithmic and digital systems should be used at all in some circumstances.

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