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Understanding the Digital Disruption of Health Care: An Ethnographic Study of Real-Time Multidisciplinary Clinical Behavior in a New Digital Hospital

Oliver J. Canfell[1,2,3,4] Yasaman Meshkat[5] Zack Kodiyattu[5] Teyl Engstrom[1,4] Wilkin Chan[5] Jayden Mifsud[5] Jason D. Pole[1,4] Martin Byrne[6] Ella Van Raders[6] Clair Sullivan[1,4,6]

[1] Centre for Health Services Research, Faculty of Medicine, The University of Queensland, Herston, Queensland, Australia
[2] UQ Business School, Faculty of Business, Economics and Law, The University of Queensland, St Lucia, Queensland, Australia
[3] Digital Health Cooperative Research Centre, Australian Government, Sydney, New South Wales, Australia
[4] Queensland Digital Health Centre, The University of Queensland, Herston, Queensland, Australia
[5] School of Clinical Medicine, Faculty of Medicine, The University of Queensland, Herston, Queensland, Australia
[6] Metro North Hospital and Health Service, Department of Health, Queensland Government, Herston, Queensland, Australia

Address for correspondence Oliver J. Canfell, PhD, The University of Queensland, Level 5 Health Sciences Building, Herston, QLD 4006, Australia (e-mail: o.canfell@uq.edu.au).

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Abstract

Background Understanding electronic medical record (EMR) implementation in digital hospitals has focused on retrospective "work as imagined" experiences of multidisciplinary clinicians, rather than "work as done" behaviors. Our research question was "what is the behavior of multidisciplinary clinicians during the transition to a new digital hospital?"

Objectives The aim of the study is to: (1) Observe clinical behavior of multidisciplinary clinicians in a new digital hospital using ethnography. (2) Develop a thematic framework of clinical behavior in a new digital hospital.

Methods The setting was the go-live of a greenfield 182-bed digital specialist public hospital in Queensland, Australia. Participants were multidisciplinary clinicians (allied health, nursing, medical, and pharmacy). Clinical ethnographic observations were conducted between March and April 2021 (approximately 1 month post-EMR implementation). Observers shadowed clinicians in real-time performing a diverse range of routine clinical activities and recorded any clinical behavior related to interaction with the digital hospital. Data were analyzed in two phases: (1) content analysis using machine learning (Leximancer v4.5); (2) researcher-led interpretation of the text analytics to generate contextual meaning and finalize themes.

Keywords
- electronic medical records
- eHealth
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- digital hospital
- digital health
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Results A total of 55 multidisciplinary clinicians (41.8% allied health, 23.6% nursing, 20% medical, 14.6% pharmacy) were observed across 58 hours and 99 individual patient encounters. Five themes were derived: (1) Workflows for clinical documentation; (2) Navigating a digital hospital; (3) Digital efficiencies; (4) Digital challenges; (5) Patient experience. There was no observed harm attributable to the digital transition. Clinicians primarily used blended digital and paper workflows to achieve clinical goals. The EMR was generally used seamlessly. New digital workflows affected clinical productivity and caused frustration. Digitization enabled multitasking, clinical opportunism, and benefits to patient safety; however, clinicians were hesitant to trust digital information.

Conclusion This study improves our real-time understanding of the digital disruption of health care and can guide clinicians, managers, and health services toward digital transformation strategies based upon "work as done."

Background and Significance

Digital transformation of health care has been rapidly advancing on a global scale for more than two decades. Health care has now been disrupted on a ferocious scale and speed due to the coronavirus disease 2019 (COVID-19) pandemic.[1] Digital transformation has accelerated as a matter of necessity, particularly for digital epidemiological surveillance, digital diagnostics and genomics, wearables and sensors, machine learning and predictive analytics for pandemic forecasting, and virtual care, digital hospitals and telehealth to create adaptive and improved models of care.[2,3]

The World Health Organization Global Strategy on Digital Health (2020–2025) recommends implementation of nationally-standardized digital health architecture, including digital hospitals.[4] In the United States, 80.5% of hospitals have adopted at least a basic electronic medical record (EMR) system but only 39.1% have implemented a comprehensive EMR.[5] In Australia, 65% of hospitals have implemented an EMR. Introducing EMRs in hospitals radically disrupts well-rehearsed clinical workflows and creates unfamiliar clinical environments potentially impacting interprofessional communication and the quality and safety of care.[6,7] Previous research has identified digital disruption "syndromes" that occur during a digital hospital "go-live" period (approximately 3 months post-EMR implementation),[6] including "digital deceleration" (transient reduced operational efficiency), "digital hypervigilance" (tendency to unnecessarily change routine protocols or overreact to potential digital issues), and "post-digital depression" (organizational change fatigue).[6]

Poor understanding and management of this digital disruption have contributed to the failure of over 50% of EMR implementations.[6] Past research has studied "work as imagined" – a retrospective recall of attitudes, perceptions, and experiences of EMR implementation. These have been delayed up to 3 years post-transformation, in siloed clinical disciplines (e.g., medical, nursing, or allied health only) or using cross-sectional survey or phenomenological (interviews/focus groups) methods.[8–13]

These methods are retrospective and narrow; there is a need for real-time observation of multidisciplinary clinical team behavior during the digital disruption of health care. Ethnography (observational recording of specific populations, groups, or communities) can provide a rich understanding of the real-time disruption and complexity of digital hospital transformation and its impact on clinical behavior.[14–18] Understanding can then mature from "work as imagined" to "work as done" – what actually happens in real-time.[15] To our knowledge, ethnography is yet to be applied to large-scale digital disruption of health care and can be used to guide clinicians, decision-makers, and health services to optimize future digital hospital transformations.

Given the need for better management of digital disruption and the lack of guidance in this area, our research question was "*what is the behavior of multidisciplinary clinicians during the transition to a new digital hospital?*" We hypothesized multidisciplinary clinicians will experience disruption of their workflows during the go-live period of adjustment (approximately 3 months post-implementation) and may exhibit digital disruption "syndromes."[6] The aim of this study was to explore clinical behavior of multidisciplinary clinicians in a new digital hospital using an ethnographic approach.

The objectives of this qualitative ethnographic study were to:

(1) Observe clinical behavior of multidisciplinary clinicians in a new digital hospital using ethnography.
(2) Develop a thematic framework of clinical behavior in a new digital hospital.

Methods

Study Design

The Standards for Reporting Qualitative Research (SRQR) criteria were followed (►**Supplementary Appendix A**, available in the online version).[19] Clinical ethnographic observations were conducted in one round of data collection commencing March 2021 and concluding April 2021 (approximately 6 weeks total). Data collection commenced approximately 1-month after go-live with the intention of observing clinical behavior during the wash-in period of a digital hospital transformation. The study design was grounded in two evidence-based frameworks: (1) framework for direct observation of performance and safety in

health care,[15] and (2) National Institute of Health (NIH) Guide to Clinic Ethnography.[20]

This study was granted ethical approval by the human research ethics committee (HREC) at the target hospital and health service setting (HREC/2020/QRBW/69963) and ratified by an academic institutional HREC (2020/HE003004). Site research governance approval was granted by the relevant hospital and health service governance committee (SSA/2021/QRBW/69963).

Setting and Participants

The setting was a brand-new, greenfield 182-bed (100 as rehabilitation-specific) specialist public hospital facility in Queensland, Australia ("HospitalQ"). HospitalQ provides new and expanded health care services that prioritizes rehabilitation and low complexity, elective, short-stay surgical procedures across targeted specialty areas, including ears, nose and throat, general, ophthalmology, orthopaedics and urology.

HospitalQ go-live was in February 2021. HospitalQ opened operating with a HIMMS level 6 EMR. This site was purposively chosen as it was a brand-new digital facility and there was a unique opportunity to qualitatively observe the real-time impact of digital transition as multidisciplinary hospital staff navigated a new digital hospital, most for the first time. Many hospital staff had directly transitioned from an adjacent acute public hospital site (on the same campus) that used paper-based clinical records. Participants were clinicians (allied health, nursing, medical, and pharmacy) undertaking routine clinical activity.

Recruitment and Consent

A stepwise recruitment strategy was implemented that prioritized all-inclusive clinician engagement and relationship-building to mitigate any potential Hawthorne effect[21] (►Fig. 1).

Three sampling strategies were implemented to enable maximum participation and participant variation. Convenience sampling was used to opportunistically recruit clinicians at routine clinical meetings, purposive sampling was used to target specific clinical disciplines (e.g., nursing or pharmacy only) to enable sampling saturation, and snowball (chain) sampling was used to identify prospective participants via existing participants. Recruitment ceased once (a) sampling saturation was reached across all four target clinical disciplines, and (b) observational data saturation was achieved, as decided by discussion and consensus between authors.

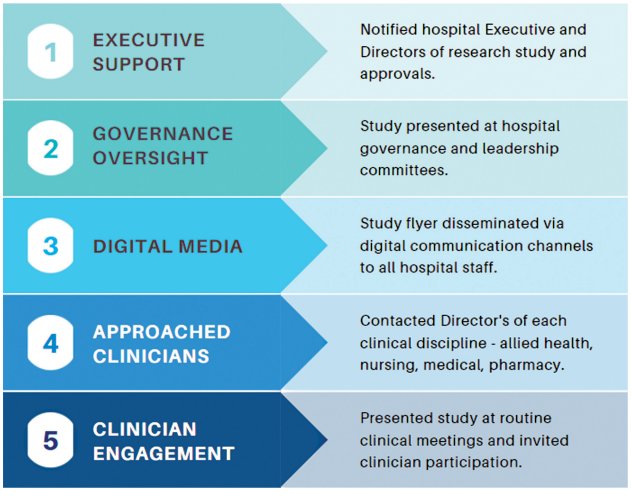

Fig. 1 Recruitment strategy to maximize clinician engagement in the present ethnographic study.

Participants were asked to provide their verbal consent to be observed. Individual patients were also asked for their verbal consent to have the observer present. Participants were provided with information about the study aims but no additional information was provided to limit any potential Hawthorne effect.[21] Participants were offered the opportunity to withdraw any observation pertaining to their clinical behavior. No patient data was recorded and there was no observer–patient interaction. There was no pre-established observer–participant relationship.

Clinical Ethnographic Observations

An "observer as participant" approach was adopted. Observers (a postdoctoral researcher [O.J.C.] and research assistants [Y.M., Z.K., W.C., and J.M.]) shadowed multidisciplinary clinicians performing routine clinical activity at HospitalQ. Observers shadowed general clinical activity, inpatient ward rounds, outpatient appointments, perioperative workflows, and validation protocols for new clinical analytics products between 0700 and 1400.

A custom clinical ethnographic data collection tool was co-designed and internally validated by the research team (►Supplementary Appendix B, available in the online version). The workflow design was theoretically grounded in evidence-based frameworks for conducting clinical ethnography.[15,20] A mock observation was conducted at each workshop using virtual YouTube ward rounds to interrogate and improve the workflow. The final data collection tool (►Supplementary Appendix B, available in the online version) was piloted at HospitalQ prior to the commencement of data collection by a researcher-research assistant dyad performed two observations together and triangulated their independent observations to confirm validity.

Clinician demographic and environmental data were recorded for each observation, including: participant clinical discipline (allied health, nursing, medical, and pharmacy), student status, estimated age range (20–29, 30–39, 40–49, 50–59, and >59), if it was the participant's first observation, total duration (hh:mm), clinician context (individual, intradisciplinary team, multidisciplinary team), clinical activity (ward, dynamic, outpatient), clinical area (rehabilitation, geriatrics, procedural, rehabilitation engineering, outpatients, endoscopy, and digital innovation), total number of patients observed, and total number of clinicians observed. Observations were conducted in "events," where multiple participants and workflows could have been observed in a single observation event.

Observers recorded any clinical behavior related to interaction with the digital workflows and any of its clinical components (e.g., clinician activity, efficiency, errors, verbal

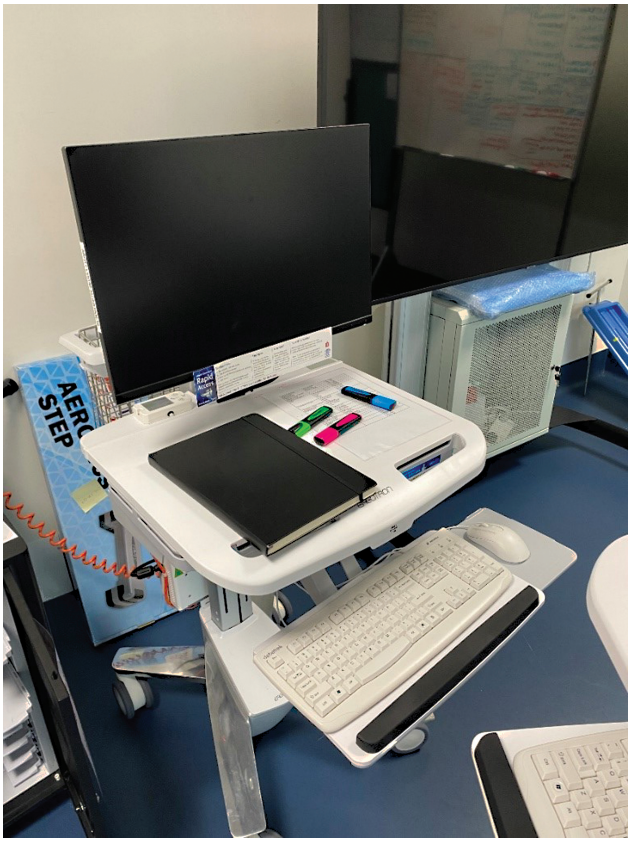

Fig. 2 Workstation on Wheels (WOW) in HospitalQ – a digital hospital in Queensland, Australia.

expressions, using the EMR in the context of clinical assessment and decision-making, operating a "workstation on wheels" [WOW]) (►**Fig. 2**). Time spent completing individual digital tasks during an observation event was not recorded; the collection burden was high and it would have been difficult to meaningfully analyze task data.

Observations were recorded using detailed handwritten notes – a "thick," rich approach to ethnographic data collection that offers flexibility in analysis and interpretation[15]– across three domains: (1) Descriptive (objective) – "what is happening?" (2) Analytical (subjective) – "what does that mean?" (3) Participant verbal expressions/quotes. Observers stressed to participants that clinical behavior was only being observed in the context of interacting with the digital workflow, and not in the context of analyzing or judging clinical behavior or decisions. Handwritten notes were typed in full into an Excel spreadsheet as soon as feasible following data collection. After an observation, observers asked each participant how being observed affected their clinical behavior. Observations continued until data saturation was achieved and there was an approximate even distribution in data collected for observed disciplines.

Data Analysis

Observational data were analyzed in a two-stage approach. The first two stages emulate the analysis protocol of Haynes et al.[22]

Stage One–Unsupervised Machine Learning

The first stage of analysis was undertaken via the text analytics tool "Leximancer" (v4.5).[23] Leximancer applies an unsupervised machine learning algorithm that uncovers networks or patterns of word- and name-like terms in a body of text.[22] It then generates unbiased interconnections, structures and patterns between terms to develop "concepts" – collections of words that are linked together within the text – and group them into "themes" – concepts that are highly connected.[22] Leximancer displays the inter-relationships between concepts and themes visually. Its advantages include expedition of the early stages of qualitative analysis and providing a first unbiased analysis of qualitative data.

One researcher loaded the observational data into Leximancer and created an initial concept map (a birds-eye analysis of the text) without altering any settings. Leximancer's tagging functionality was also used to stratify and analyze data according to clinical discipline (allied health, nursing, medical, and pharmacy) as an observational subgroup. Concepts were then iteratively reviewed for Lexical "value" and removed where appropriate. Concepts were merged and compound concepts were created where relevant. The concept map was initially observed at a summary level through "zooming out" then individual themes and concepts were investigated in more detail by "zooming in" as described by Haynes et al.[24] Multiple theme sizes (or "granularity") were trialed to arrive at the final concept map where a theme granularity of 48% was used.

Stage Two–Researcher-Led Interpretation

A second stage of researcher-led interpretive analysis was applied to the preliminary themes and concepts identified by Leximancer's text analytics. Leximancer was queried for samples of text that supported each preliminary theme and concept. Relevant text was extracted by one researcher. Manual inductive, thematic analysis was performed by two researchers across three iterative rounds of grouping to generate new, interpretive themes and sub-themes based on contextual understanding of the field (digital health) and observed clinical behavior at HospitalQ.

Results

Participant Characteristics

►**Table 1** presents participant characteristics. A total of 55 multidisciplinary clinicians were observed across four clinical disciplines: allied health (23, 41.8%), nursing (13, 23.6%), medical (11, 20.0%), and pharmacy (8, 14.6%). Most participants were estimated to have age ranges 20 to 29 (29, 52.7%) and 30 to 39 (17, 31.0%). Two (3.6%) participants observed were medical students. No participants declined observation when directly approached.

Observation Events

►**Table 2** presents characteristics of clinical ethnographic observations. Observers conducted 38 unique observation events that totaled 58 hours and 99 individual patient interactions within HospitalQ. Clinicians were mostly observed

Table 1 Characteristics of participants in clinical ethnographic observations

Characteristic	Total (*n*)	*n* (%)
Participants	**55**	
Clinical discipline		
Allied health		23 (41.8)
Nursing		13 (23.6)
Medical		11 (20.0)
Pharmacy		8 (14.6)
Estimated age range		
20–29		29 (52.7)
30–39		17 (30.9)
40–49		7 (12.7)
50–59		2 (3.6)
60–69		0 (0)
> 70		0 (0)
Student status		
No		53 (96.4)
Yes		2 (3.6)

Table 2 Characteristics of clinical ethnographic observations

Characteristic	Total (*n*)	*n* (%)
Observations		
Hours	58	
Number of patients observed	99	
Events	**38**	
Clinical setting		
Geriatrics		10 (26.3)
Rehabilitation		9 (23.7)
Outpatients		8 (21.1)
Procedural		6 (15.8)
Rehabilitation engineering		2 (5.3)
Digital innovation		2 (5.3)
Endoscopy		1 (2.6)
Clinical team		
Individual		25 (65.8)
Multidisciplinary		8 (21.1)
Intradisciplinary		5 (13.2)
Clinical activity		
Dynamic		16 (42.1)
Ward		15 (39.5)
Consultation		7 (18.4)

conducting routine clinical activity in geriatrics (26.3%), rehabilitation (23.7%), outpatients (21.1%), and procedural (15.8) settings. Clinicians were observed individually (25, 65.8%), as part of multidisciplinary teams (8, 21.1%), or intradisciplinary teams (5, 13.2%). Observed clinical activity was predominantly dynamic (i.e., highly mobile and practical) (16, 42.1%) and ward-based (15, 39.5%), likely due to the rehabilitation focus of HospitalQ. Consultations were observed less frequently (7, 18.4%).

Stage One–Identifying Preliminary Themes and Concepts

►**Fig. 3** shows the inter-topic concept map derived from the clinical ethnographic data. From Leximancer's machine learning analysis, this map illustrates themes as colored bubbles that are heat-mapped according to their frequency ("importance"), with warmer colors (e.g., red, yellow) indicating higher importance and cooler colors (e.g., blue, purple) lower importance. Concepts are displayed as dots within each colored theme bubble and inter-linked across themes. Closer proximity of the colored bubbles or concept dots indicate higher co-occurence.[22]

Overall, six themes were automatically derived (in order of identified "importance"): notes; medication; EMR; WOW; screen; and data. The analysis identified 39 total concepts within all themes. The ten most frequent concepts were WOW, notes, ieMR, paper, room, medication, list, digital, team and system.

Stage Two–Final Themes and Sub-themes of Clinical Behavior in a New Digital Hospital

A total of five themes and 10 sub-themes were manually derived from stage two (researcher-led interpretation of the Leximancer outputs) data analysis (►**Fig. 4**). ►**Table 3** presents key clinical ethnographic observations linked to each theme and sub-theme. We then provide narrative supportive evidence for each theme and sub-theme with (a) "stories" – observational examples that best represent each theme, and (b) participant expressions/quotes.

Theme 1–Workflows for Clinical Documentation

Theme 1 was derived from the strongest "Notes" theme identified by Leximancer that contained observations of two core but distinct workflows – digital and paper notes – for clinical documentation. Observational examples saw real-time digital documentation at the point-of-care in a variety of settings, e.g., ward hallways, an active rehabilitation gym session and outpatient clinical areas. Printed ward lists or notebooks were seen to be used for (a) personal clinical workflow tracking (b) communicating and checking clinical data with peers and the EMR. Some clinicians adopted the workflow of transcribing EMR clinical notes prior to seeing a patient, then taking handwritten notes while seeing a patient and subsequently documenting handwritten notes into the EMR (►**Table 4**).

Theme 2–Navigating a Digital Hospital

Theme 2 was derived from the "ieMR" and "WOW" Leximancer themes to characterize physical (WOWs) and virtual (EMR) navigation of a digital hospital. Nurses were observed adopting a dynamic workflow by using a WOW to administer

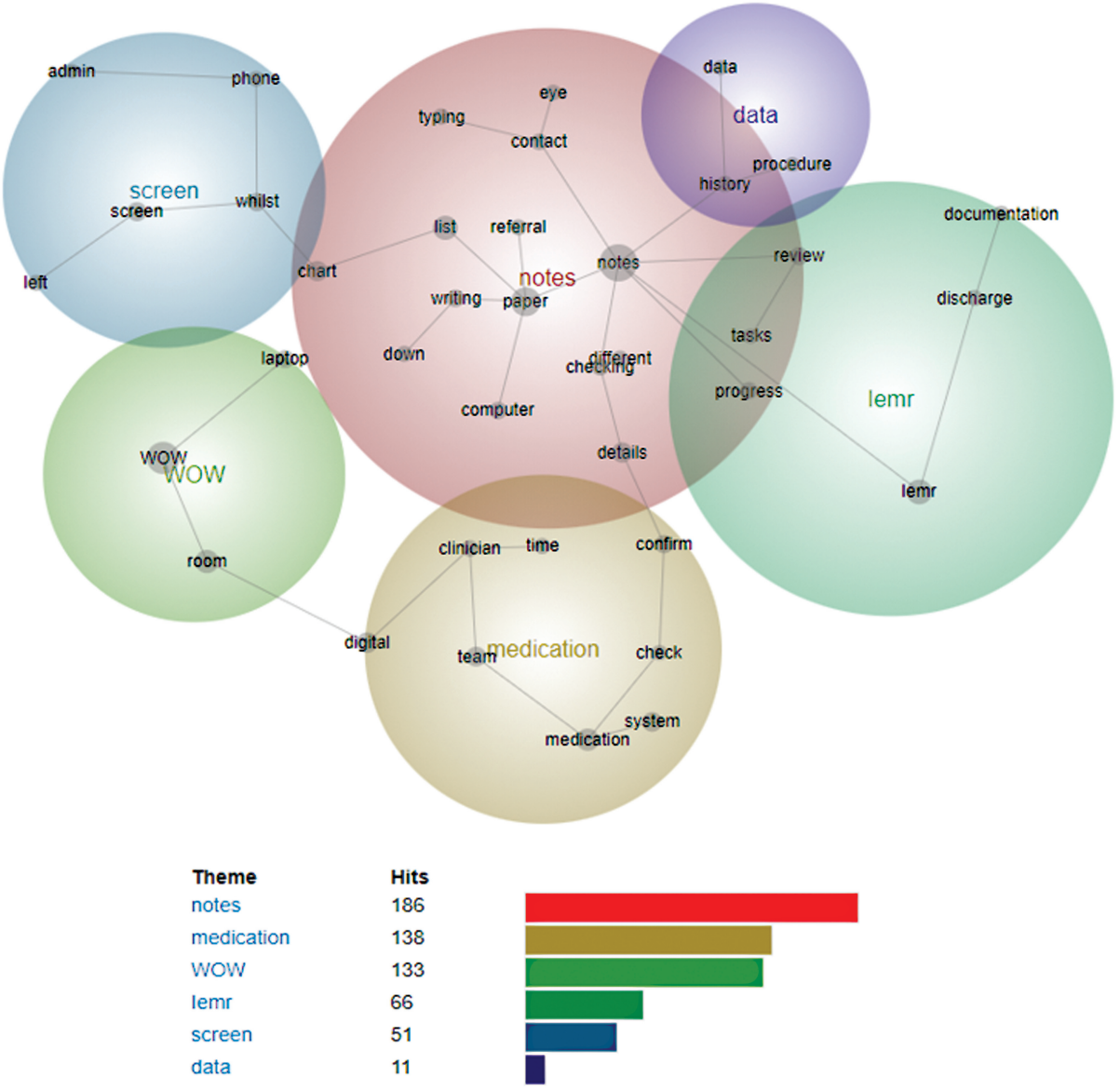

Fig. 3 Concept map from Leximancer data analysis of clinical ethnographic data. *Themes are presented as colored bubbles that are heat-mapped according to their frequency ("importance"), with warmer colors (e.g., red, yellow) indicating higher importance and cooler colors (e.g., blue, purple) lower importance.*

medication to patients participating in a gym rehabilitation session. Observations saw many clinicians struggling to maneuver WOWs in clinical hallways and patient rooms; they were a clear obstruction to space and cumbersome to physically move. Navigation within the EMR was observed as easy and seamless when operating at a desk or WOW and a clinician navigated quickly between patient history views prior to a busy ward round (approximately 10 morning patients) (►Table 5).

Theme 3–Digital Efficiencies

Theme 3 was derived from the "Medication", "Screen," and "WOW" Leximancer themes. Digitization saw capabilities emerge relating to multitasking, opportunistic clinical care, and optimizing patient identification and safety. One observational example saw a patient seeking out their doctor in the ward hallway to further discuss their care. The clinician was able to use the WOW to opportunistically update the patient's digital clinical notes and plan. Clinicians were also seen to simultaneously navigate digital patient notes, a ward "care organizer" to help manage workflow and ward patient lists to plan their clinical approach. Pharmacist decision-making was optimized via a digital medication administration workflow that tracked patient medication timings. Nurses used an ID scanner to scan patient armbands as the primary method of validating a patient's ID prior to administering care (►Table 6).

Theme 4–Digital Challenges

Theme 4 was derived from the "ieMR," "Notes," and "Data" Leximancer themes to capture key software challenges experienced during the digital hospital transition and the

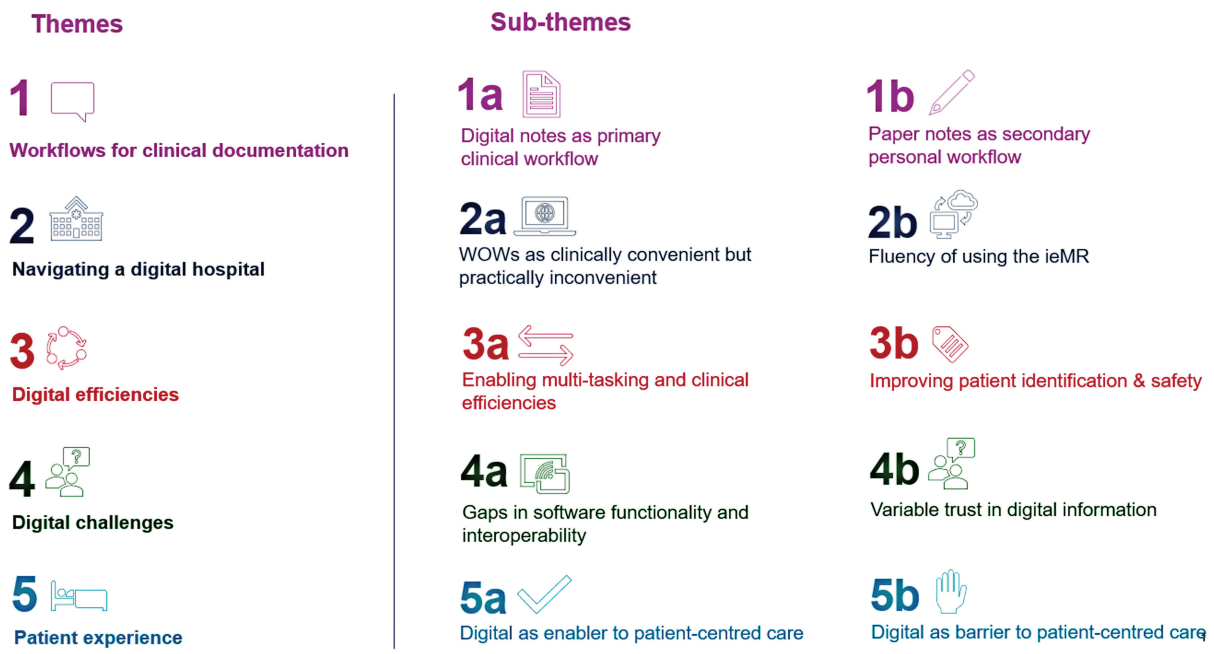

Fig. 4 Final themes and sub-themes derived from researcher-led interpretation of Leximancer text analytics.

observed trust variations that clinicians demonstrated with digital clinical information. An observational example was the lack of integration between EMR and essential clinical pharmacy software; pharmacists had to double handle information and find software workarounds. Many observations were recorded across disciplines where clinicians expressed frustrations with multiple login requirements to access clinical information, automatic timeout of WOWs and loss of clinical notes, complex software workflows to achieve a simple goal (e.g., discharge), and a hospital hierarchy of swipe access for "rapid login." Medical and pharmacy staff were granted "rapid login" access but allied health and nursing staff were not. In terms of trust, some clinicians quickly dismissed clinical decision support alerts in the EMR due to alert fatigue. Observers saw blended sources (digital, paper, and peer) were frequently used to cross-check data accuracy and reach a "clinical truth" threshold required for decision-making (►Table 7).

Theme 5–Patient Experience

Theme 5 was derived from the "Screen" and "Notes" Leximancer themes to describe the observed impact of the digital transition on enabling and inhibiting patient-centered care. Allied health clinicians were observed using a WOW to deliver patient education for a rehabilitation program via a mobile health (mHealth) app. The EMR was used by an intradisciplinary medical team to note a patient's birthday and wish them a happy birthday. One observational example saw an allied health clinician purposefully foregoing use of a WOW to take paper notes with a ward patient, citing that the WOW inhibited building a strong clinician–patient relationship, rapport, and trust. Paper remained the primary medium for delivering patient education and staff printed discharge information, clinical plans, and information sheets for patients (►Table 8).

Subgroup Analysis–Clinical Discipline

►Fig. 5 presents the inter-topic concept map derived from the clinical ethnographic data stratified by clinical discipline (allied health, nursing, medical, pharmacy). Seven themes were automatically derived (in order of identified "importance"): notes; WOW; ieMR; while; system; admin and data (►Table 9).

Allied health was linked to all seven themes. Allied health demonstrated a dynamic, practical, blended (digital and paper) and multitasked workflows (e.g., writing notes while facilitating patient care, wheeling WOW and talking to staff). Nurses were focused on patient identification and safety protocols using digital technologies, mostly related to medication administration. Nursing workflows were practical and fast-paced; nurses were rarely observed recording clinical notes. Pharmacists interacted heavily with data to validate clinical decisions and used multiple digital platforms within and outside the EMR to facilitate care delivery. Medical professionals demonstrated smooth, efficient, and consistent team-based digital workflows. Overall, the digital workflow conformed to medical and nursing clinical activity but was less optimized for allied health and pharmacy.

Discussion

Main Findings

This study explored the clinical behavior of 55 unique multidisciplinary (allied health, nursing, medical, pharmacy) clinicians in HospitalQ – a new digital hospital in Queensland, Australia – across 58 hours of ethnographic observations conducted over 6 weeks (1–2 months post-Go Live). To

Table 3 Key clinical ethnographic observations linked to each theme, sub-theme and Leximancer concept

Number	Interpreted theme and sub-theme (Stage 2)	Leximancer theme (Stage 1)	Key observations
Theme 1	Workflows for clinical documentation		
Sub-theme 1A	Digital notes as primary clinical workflow	Notes	• Recorded digital notes prior to, during, after seeing patient • Used ieMR "smart features" (e.g., QuickFill, Auto-Text') • Referred to digital notes while consulting patient
Sub-theme 1B	Paper notes as secondary personal workflow		• Made clinical notes on printed ward list, notebooks • Referred to paper notes for patient history, handovers, referrals and medication list • Paper workflow blended with digital workflow
Theme 2	Navigating a digital hospital		
Sub-theme 2A	WOWs as clinically convenient but practically inconvenient	WOW, ieMR	• WOW used for "roaming documentation" to write notes, confirm patient details, administer medications • Used for point-of-care (at bedside) clinical information • Difficulty maneuvering, hard to push, moving hazard, blocked hallways
Sub-theme 2B	Fluency of using the EMR		• Smooth navigation, targeted action • Overall familiarity with system • Difficulty reading small, typed text
Theme 3	Digital efficiencies		
Sub-theme 3A	Enabling multi-tasking and clinical efficiencies	Screen, WOW, Medication	• Using multiple screens simultaneously to navigate between clinical notes, care organizers, patients lists • Communicating between staff while consulting WOW • Point-of-care clinical documentation talking to patient, family and recording observations
Sub-theme 3B	Improving patient identification and safety		• Scanning patient armband for medication administration • Used digital timeline to assist with medication timing • ieMR notes to confirm patient identity, medication details • "Pyxis" medication system used as second source of truth
Theme 4	Digital challenges		
Sub-theme 4A	Gaps in software functionality and interoperability	ieMR, Notes, Data	• No digital patient overview – clinicians use paper lists • Frustration with multiple logins, system freezing, loss of data • Key clinical processes (discharge summaries, patient transfers, medication supplies, patient appointments) don't integrate with ieMR
Sub-theme 4B	Variable trust in digital information		• Decision support often ignored and quickly dismissed • Manual validation of digital clinical and dashboard data • Cross-checked digital data with other clinicians, paper notes
Theme 5	Patient experience		
Sub-theme 5A	Digital as enabler to patient-centered care	Screen, notes	• Used multimedia videos and digital notes to conduct patient case conferences • Additional visual medium for communicating with pts
Sub-theme 5B	Digital as barrier to patient-centered care		• WOWs sometimes obstructed building patient rapport and trust • Whiteboards used for communicating generally with pts

Abbreviation: ieMR, integrated-electronic medical record.

Table 4 Participant quotes supporting theme 1

"I love ieMR. Such a helpful tool as a clinical assistant" (Pharmacy, Procedural, Ward)
"We made templates so the notes are standardized and they're based on our old forms" (Allied Health, Engineering, Dynamic)
"Feel free to keep going [with your exercises] while I type up these notes" (Allied Health, Outpatients, Dynamic)
*"Oh, and watch me use the computer?" *Sarcasm, laughs. While using paper notes* (Allied Health, Geriatric, Ward)*

Table 5 Participant quotes supporting theme 2

"I find WOWs really clunky..." (Pharmacy, Procedural, Ward)
"I have to be a precision driver these days" (Medical, Rehabilitation, Ward)
"System is good overall but some guidelines would be helpful" – (Nurse, Procedural, Ward)
"It's so easier to find your own documentation now. Overall the workflow is smoother" (Allied Health, Outpatients, Consultation)

Table 6 Participant quotes supporting theme 3

"I couldn't go back to a paper hospital" (Medical, Geriatrics, Ward)
"I'm sold on ieMR. You get a whole overview without disrupting anyone else's workflow" (Pharmacy, Procedural, Ward)
"I'm seeing a lot more patients than I would normally see" (Allied Health, Geriatrics, Ward)
"Digital is just awesome. It's just all there. We used to have to fight for charts" (Pharmacy, Procedural, Ward)
"Initially it was just another thing to fill in but now we're more efficient. Overall, it's reduced risk of error. Notes are more legible" (Medical, Rehabilitation, Ward)
"Digital is amazing for patient safety" (Pharmacy, Procedural, Ward)

Table 7 Participant quotes supporting theme 4

"I don't have rapid access yet so you'll see me log in a million times" (Nurse, Rehabilitation, Ward)
"We have to double handle things like allergies between softwares – it's not great" (Pharmacy, Procedural, Ward)
"Patients comment on the login experience and how bad it is" (Allied Health, Outpatients, Consultation)
"CDSS is really... you get alert fatigue. So you miss things" (Pharmacy, Procedural, Ward)
*"So you sign ieMR off at the bedside, right?" *Confirming digital process* (Nurse, Rehabilitation, Ward)*

Table 8 Participant quotes that support theme 5

"I normally work through the resources on the WOW with the patient" (Allied Health, Outpatients, Consultation)
"I wouldn't take a computer into a session with a patient because it is clunky" (Allied Health, Rehabilitation, Ward)
**While slow typing* - "Can you imagine me doing this whilst seeing a patient?" (Allied Health, Rehabilitation, Dynamic)*
"We use the systems after gym. It makes it easier for notes and to see the patients" (Allied Health, Geriatric, Dynamic)
*"No, we need to print it" *Patient asking if they can receive a digital copy of their results* (Allied Health, Outpatients, Dynamic)*

our knowledge, this was the first time that multidisciplinary clinical behavior was observed in real-time in a new digital hospital. Critically, there was no observed harm or negative impact to patient care attributable to the digital transition. Overall, clinicians primarily used digital workflows that were supported by personal paper workflows. The EMR system was seamlessly navigated; however, software inefficiencies and interoperability challenges affected clinical productivity and caused frustration. The WOWs offered roaming clinical opportunism but were large physical obstructions and sometimes barriers to delivering patient-centered care. Digitization enabled multitasking efficiencies and benefits to patient safety, particularly for medication administration; however, clinicians were hesitant to trust pure digital information and sought additional sources of truth (paper and peer support) to validate clinical data. Digital transformation of health care had transformed the clinician experience but observers were cognizant that benefits to the patient experience remained unknown.

Comparison with Previous Research

Previous research has primarily investigated perceptions of hospital staff toward EMR implementation rather than observed or reported clinical behavior. Immediately after implementation of an EMR in five large Australian hospitals, multidisciplinary staff conveyed mildly positive perceptions of system quality, information quality, and individual benefits.[9] These benefits were not shared equally between sites or professions, suggesting that EMR implementation affects disciplines differently – both positively and negatively – and single-site approaches may bias results.[9] These results aligned with our subgroup analysis of clinical behavior by discipline, where clinicians demonstrated heterogenous workflows and adopted unique adjustments to optimize interaction with the EMR.

In another digital rehabilitation hospital setting in Australia, frontline EMR implementation was found to intensify and negatively disrupt clinical workflows, and adaptation was required to overcome new documentation burdens.[25] Multidisciplinary clinicians in our study adopted a blended (digital and paper) workflow to effectively manage new technological burden. We observed that EMR provided both positive and challenging disruptions, such as improving multitasking and care organization efficiencies while presenting new software interoperability difficulties. This is a "digital deceleration" syndrome that sees blended efficiencies and inefficiencies, both caused by digital transformation.[6] Burridge et al[25] also found that EMRs reduced

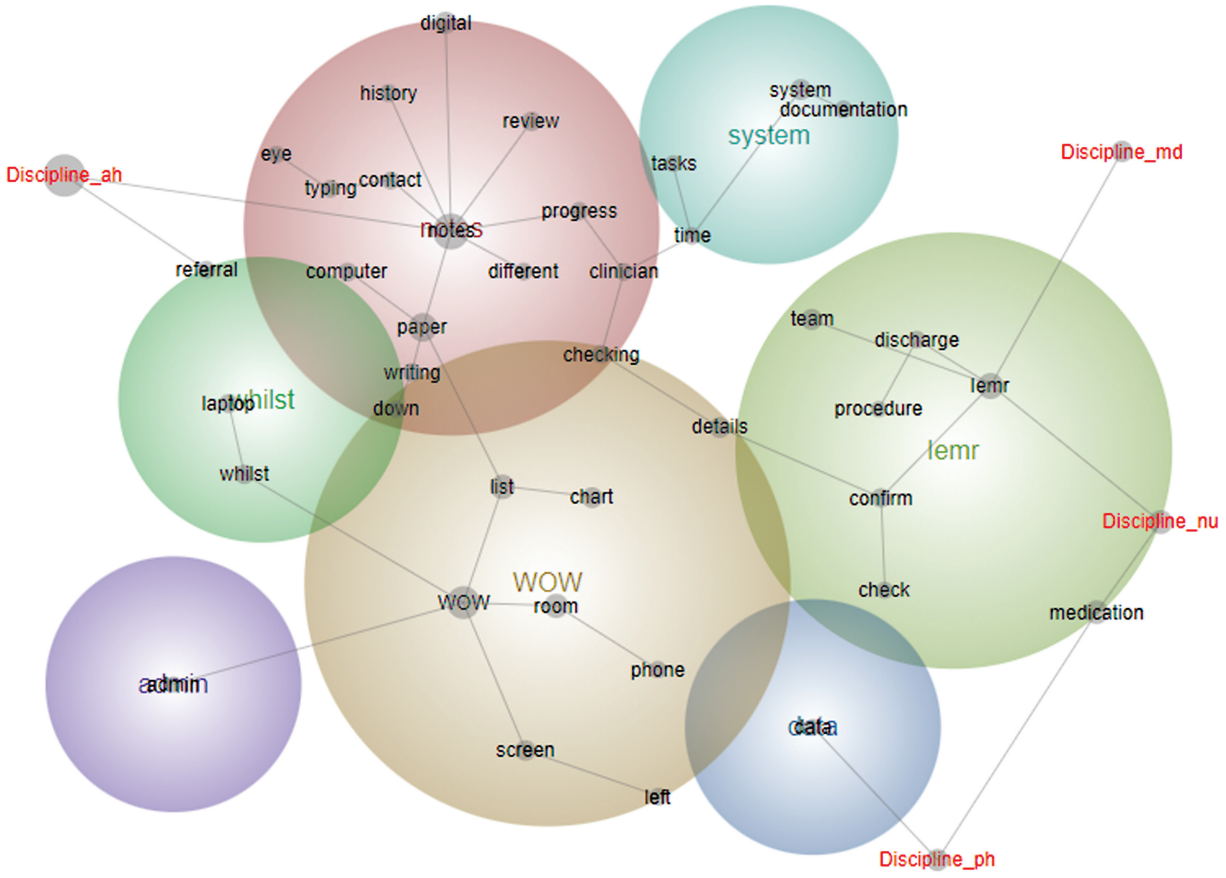

Fig. 5 Concept map from Leximancer data analysis of clinical ethnographic data stratified by clinical discipline. *Themes are presented as colored bubbles that are heat-mapped according to their frequency ("importance"), with warmer colors (e.g., red, yellow) indicating higher importance and cooler colors (e.g., blue, purple) lower importance.* ah, allied health; md, medical; nu, nursing; ph, pharmacy.

opportunities for informal multidisciplinary interaction. Our results indicated the opposite was true; both clinicians and patients utilized WOWs and EMR to perform opportunistic clinical care, such as brief hallway consultations or medication administration during a gym session. Despite this opportunism, WOWs and the EMR were sometimes seen as intrusions to patient encounters and limited patient–clinician relationship building in our observations and Burridge et al results.[25]

Clinical and Health Service Implications

Unlocking the true value of digital health starts with EMRs as the foundational infrastructure of a learning health system (LHS), where clinical data are continuously analyzed in real-time to generate new knowledge that improves care of subsequent patients in an iterative, virtuous learning cycle.[26] A true LHS is a strong enabler to achieve the Quadruple Aim of health care[27]–better outcomes,[28] reduced cost,[29] improving patient experience and improving clinician experience.[27] We deductively mapped our results to the Quadruple aim to highlight broad clinical and health service implications arising from our new understanding of real-time digital disruption.

Observations aligned with the "Better Outcomes" quadrant by revealing a high standard of the quality and safety of care, digitization enabling clinical opportunism, and the presence of granular clinical information that can lead to better decisions at the point-of-care. A mixed effect was found for "Value," as observers reported a variable efficiency of digital workflows and inconsistency in functionality could expend invaluable clinical time. Results were naturally biased toward the "clinician experience" quadrant: digitization enabled cross-disciplinary workflows, collaboration and learning; and clinicians sought a single source of information truth and paper workflows were often an essential component to validating information. Exploring "Patient Experience" was outside the scope of this study; however, there was no obvious impact of digitization on patient experience. Observers noted digital literacy may mediate patient experience; patients with higher digital literacy may be more capable in navigating digital health care,[30] and portable WOWs could have privacy implications for patients if left unattended.

Our results reveal important implications for multidisciplinary clinicians, health services, and patients as multinational jurisdictions continue to rapidly digitally transform acute care hospitals. As the objective of this study was to understand clinical behavior in a new digital hospital setting, future research can adopt a theory-driven approach to consider how these two systems – human and technology – can be optimized together to improve digital transformation and digitally-driven decision-making.[31] This study has

Table 9 Participant quotes supporting subgroup analysis by clinical discipline

"Sorry, I'm not doing many things digital – this is physio!" – Allied Health, Procedural, Ward
"We're definitely not using its full functionality" – Allied Health, Engineering, Dynamic
"Not all of our software is in software center" (Pharmacist, Procedural, Ward)

Table 10 Potential training domains to optimize new EMR implementations

1. Blended (digital and paper) workflows must be embraced and supported by clinical teams during digital transition to allow safe adaptation to new technological burdens.
2. Health services acknowledge that digitization affects clinical disciplines differently as their workflows and clinical goals are heterogenous: discipline-specific education may be required to create "clinician-centred" EMR training and implementation support.
3. Addressing trust in digital information must be prioritized to ensure clinicians feel confident in underlying clinical EMR data to make quick decisions.
4. Digital-patient etiquette that encourages a patient-sensitive approach to digital workflows adaptable to each clinical discipline and area (e.g., social work may require higher sensitivity than nursing).

identified new potential training domains (►Table 9) to help advance hospitals from successful EMR implementation to *optimized* EMR implementation. This can maximize clinician usability, an important predictor of burnout, job dissatisfaction, and inpatient mortality.[32] Future research can investigate how implementing tailored multidisciplinary training prior to digital hospital implementation can negate symptoms of disruption (►Table 10).

Strengths and Limitations

To our knowledge, this study is the first to explore real-time multidisciplinary clinical behavior in a brand-new digital hospital using an ethnographic approach. Participants were recruited across all clinically active disciplines (allied health, nursing, medical, pharmacy) and observed conducting routine clinical activity across ward, outpatient, procedural and rehabilitation settings. Data analysis was strengthened with a first-stage unsupervised machine learning (via Leximancer) approach to provide unbiased text analytics that supported second-stage thematic analysis. A data collection tool was developed and internally validated for clinical ethnography in digital hospital settings and may be readily translated to other jurisdictions seeking to perform real-time observations of clinical behavior.

Our study had several limitations. We sought to characterize clinician experience in a new digital hospital and thus observations of patient experience due to the digital transition – while critically under-researched – were not able to be considered. Observations were conducted across a relatively cross-sectional 6-week period at a single site, meaning we could not assess temporal changes or geographic differences in clinical behavior. During observations, participants may have been more likely to express frustrations rather than positive experiences – the "negativity bias" psychological phenomonon.[33] Clinicians at HospitalQ were simultaneously adjusting to a new hospital in addition to digitization. Additionally, observations were predominantly conducted during mornings (approximately 7 a.m. to 2 p.m.), potentially missing critical clinical behaviors related to care digitization outside of those hours. Finally, this study offers insights into clinical behavior at a brand-new digital hospital (receiving a transition of services), which may be less transferable to an existing site that has undergone transformation from paper to digital.

Conclusion

This ethnographic study of multidisciplinary clinical behavior in a new digital hospital observed blended (digital and paper) workflows, fluid EMR navigation, clinical efficiencies enabled by digitization, clinical and information challenges raised by digitization and both enablers and barriers to patient-centered care. Our results advance understanding of the real-world impact of digital disruption of health care and can guide clinicians, managers, and health services toward managing disruption effectively and implementing digital transformation strategies based upon "work as done."

Clinical Relevance Statement

This study can provide evidence-based guidance for health services to optimize digital hospital transformations based upon observed multidisciplinary clinical experience. Clinicians can learn and understand multidisciplinary differences in digital transformation workflows to optimize efficiencies and tackle barriers to best-practice decision-making.

Multiple Choice Questions

1. In a new digital hospital, what workflow is most commonly observed in multidisciplinary clinicians?
   a. Digital only.
   b. Paper only.
   c. Blended (digital and paper).
   d. Peer discussion.

   Correct Answer: The correct answer is option c. This is the correct answer based upon our real-time ethnographic observations in our single site.

2. How can ethnography be used as a methodology to better understand and improve health care?
   a. To observe settings and behaviors in real-time.
   b. To focus on "work as done" rather than "work as imagined."
   c. To qualitatively measure a disruptive change or new process.
   d. All of the above.

Correct Answer: The correct answer is option d. Ethnography allows for low-burden, real-time observation of people, places and settings to enrich contextual understanding of health care.

Protection of Human and Animal Subjects

This study was granted ethical approval by the human research ethics committee (HREC) at the target hospital and health service setting (HREC/2020/QRBW/69963) and ratified by an academic institutional HREC (2020/HE003004). Site research governance approval was granted by the relevant hospital and health service governance committee (SSA/2021/QRBW/69963).

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Conflict of Interest

None declared.

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