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Technology for Quintuple Aim: Evidence of Technology Innovations in Reaching the Aim of Health Equity.

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Abstract. The Quintuple Aim for Health Care Improvement by the Institute for Healthcare Improvement (IHI), underscores the importance of balancing between an improved patient experience (through patient-centered, timely, and safe care), population health outcome, lower costs, and clinician well-being and health equity for optimizing health system performance. Equitable care is about providing care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographic location, and socioeconomic status. An emphasis on healthcare equity guarantees that a healthcare system must reduce inequities in healthcare processes and outcomes, particularly for those from low-income families and the underserved. For our paper, we are interested in discovering the state of the literature on the Quintuple Aim while mining for evidence of technology innovations in reaching the aim of health equity. Conclude with nudges in transforming our care system into a self-learning health system.

Keywords: Quintuple aim; equitable care; telehealth; artificial intelligence

1   Introduction

Health equity is a crosscutting element in the 2030 Agenda for Sustainable Development goals (SDGs), acknowledged by all United Nations Member States in 2015. They do so within an evidence-based conceptual framework. A framework designed to assist nations in creating consistent action across the SDGs' sectoral goals and target areas. Focusing on health equity as an outcome of development is consistent with the SDG's directive to leave no one behind, offers a means of bringing sectoral objectives together, and links action on the 17 goals.

Equitable care is about providing care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographic location, and socioeconomic status [1]. An emphasis on health care equity guarantees that a purposeful structure health-care system is to reduce inequities in health-care processes and outcomes, particularly for those from low-income families. Even before COVID-19, the digital revolution was well underway. During a period of health care reform, all areas associated to the health care system—from legislation and payment systems to delivery design, assessment, patient engagement/democratization, training, and research, should be aligned with enhancing health care value and equity [2].

1.1 A Fifth Aim to Optimize Health System Performance

To optimize health system performance, the triple aim is still the Institute for Health Improvement's guiding principle, an essential component of the healthcare value equation (IHI.org). The triple aim stipulates that value-based care be achieved by increasing patient experience, enhancing population health, and cutting healthcare costs. A fourth aim was added in 2014 to form the Quadruple Aim. The premise for this fourth aim was that health improvement would not be reachable without physician and healthcare practitioner's satisfaction [4]. About half a decade later, the Quintuple Aim is the new contest today, which has become especially important over the last two years, as we can no longer disregard health inequities underscored by the COVID-19 pandemic. The case is made once more that we cannot realize our value proposition of the right care, at the right place, at the right cost, without the demand for health justice. Therefore, the Quintuple Aim mandates a committed practice to assess vulnerable communities when considering healthcare delivery. This entails, among other things, taking into account factors like race, age, and people with disabilities, living in rural areas and in poverty. There is a connection between people's access to and understanding of health services and their own health. Healthy people must have access to primary care, healthy food and environment, transportation, income levels, social support, health insurance coverage, and health literacy. These social determinants of health (SDOH) have a major impact on people's health, well-being, and quality of life and account for 80% of all health outcomes. The ability of clinicians, payers, and other healthcare stakeholders to understand how these non-clinical determinants influence the health trajectories of the patients they care for is critical to effective and equitable population health and cost management. Equity in healthcare access and service coverage is also about the capacity to make decisions, assess the need, personal economic, social and cultural circumstances influencing access, and physical accessibility [3].

1.2 Technology for the Quintuple Aim

Disruptive technology must be widely utilized before society can adjust to it. The pandemic, however, has hastened digital adoption, resulting in a substantial shift in healthcare delivery in a short period[1], bringing much-needed attention to the lack of health equity in the United States and throughout the world. Socially marginalized populations, such as racial and ethnic minorities, older adults, and people living in poverty, had higher rates of COVID-19 and infection-related morbidity and death, as well as more disruptions in their preventative and chronic care, almost everywhere.[2] We must be aware of the hurdles to digital literacy and access that may pose a threat to health equity. While a record 4.9 billion people used the internet in 2021, about 37% of the world's population, or 2.9 billion people, are still offline[3].

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[1] https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/how-covid-19-has-pushed-companies-over-the-technology-tipping-point-and-transformed-business-forever

[2] https://www.cdc.gov/nchs/nvss/vsrr/covid19/health_disparities.htm

[3] https://www.weforum.org/agenda/2022/01/digital-healthcare-technology-for-health-equity

In this paper, we explore the state of the literature on the subject of the quintuple aim, not to the point of saturation, rather to learn the trend of interest and the progress of the health equity concepts among academic. We also approach the subject of disruption technologies through the gateway of the response to health equity through the implementation of digital health technologies as essential means to achieving the quintuple aim.

2   State of the Literature on the Quintuple Aim

We are concerned with identifying the current state of understanding around the concept of the "Quintuple Aim"; recognizing the sorts of things we know and do not know; and then setting this within policy and practice contexts [6]. We conducted this initial scoping review as a preliminary assessment of potential size and scope of research literature around the subject of "*Quintuple Aim*" [7]. We searched Google Scholar with the key word "*Quintuple Aim*" and found 99 published articles dated through July 2022. Two independent reviewers undertook a two-stage screening process to evaluate study eligibility. This included a title and abstract scan as well as a full-text review. If articles discussed the "*Quintuple Aim*", they were included in our analysis. We mapped the key concepts underpinning the research area on Quintuple Aim, across time (Table 1; Figure 1) with the different contextual uses (Figure 2) and the main sources and types of evidence available following the methodology of Arksey and O'Malley [8]. We note that the number of published articles has grown exponentially in the last decade to about six articles per month at the time of writing this paper (Figure 1).

Nevertheless, the quintuple aim is a relatively new notion and since 2018, there was an evolution of the quintuple aim concept in the literature. We summarize our observations in Section 2.1 and present evidence of technology innovations considered for reaching the quintuple aim.

Table 1: Year over year historical interest in notions of Quintuple Aim in HealthCare from the scoping review of the literature (normalized to a monthly rate)

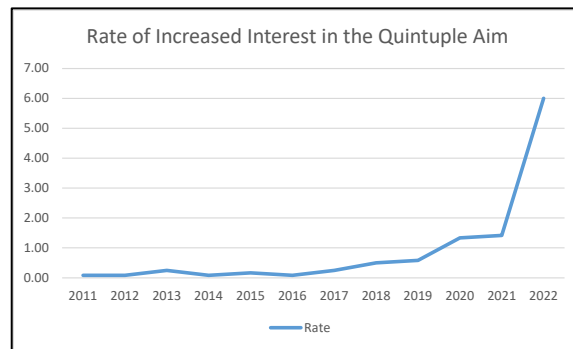| Year	N=	Rate/MTh.
2011	1	0.08
2012	1	0.08
2013	3	0.25
2014	1	0.08
2015	2	0.17
2016	1	0.08
2017	3	0.25
2018	6	0.50
2019	7	0.58
2020	16	1.33
2021	18	1.50
2022	40	5.71

Fig. 1: - Year over year historical interest in notions of Quintuple Aim in HealthCare from the scoping review of the literature (normalized to a monthly rate)

2.1 Observations from our Review

Whatever the reasons, the truth is that disparities, which existed long before the pandemic, are undesirable and avoidable. The problem now is to put this increased social awareness into practice, especially in communities, clinics, and health systems. Long defined as the Triple Aim (better health outcomes, better patient experience, and lower costs), value in healthcare ecosystems has expanded in recent years to include improvements in staff experience [4] and equity [5], bringing the definition of value to encompass all Quintuple Aim.

The Quadruple Aim of Sikka et al. [4] was a roadmap for successful health improvement: health outcome, cost, caregiver satisfaction, patient experience and provider experience [35]. Recently, in 2022, Nundy et al [5] Append "Equitable Care" to the scope of the Quintuple Aim of 2015.

The Quintuple Aim for Health Care Improvement by the IHI (Institute Healthcare Improvement), underscores the importance of balancing between improved patient experience (through patient centered, timely and safe care), population health outcome, lower costs, and clinician well-being and health equity for optimizing health system performance. Nevertheless, since 2018, there was an evolution of the quintuple aim concept in the literature. Initially, Fiscella, (2019) subsumed the quadruple aim as "Value of care," concept, adding "equity in care" as "fair-ness in processes, outcomes, and relative costs" [14]. They discussed how payment models influence primary care and the impact on the quadruple aim – defining for health equity as the fifth dimension. Birrell, et al, 2021 posited that educational collaboration can empower patients, support doctors in training and future-proof medical education. They suggested five aims to include better-quality education as well as care for the same or lower cost, enjoyable for patients, students and teaching staff [36]. Peters, 2021, added "family experience" to the quadruple aim [37] to propose a 5th aim. Charles et al, 2021, focused on digital health entrepreneurship when they explicated aims of workforce engagement, and safety [38]. While Williams et al, 2022, targeted "sick care" business processes, and revenue cycle technology [38] as the fifth aim.

In Figure 2, we illustrate a representative timeline on the notion of Quintuple Aim from the evidenced literature review. While variations were discussed between 2018 and 2022, they converged onto a concept of equity as the fifth aim.
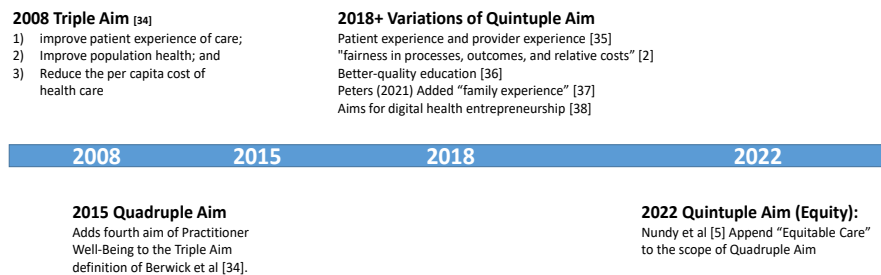

2008 Triple Aim [34]
1) improve patient experience of care;
2) Improve population health; and
3) Reduce the per capita cost of health care

2018+ Variations of Quintuple Aim
Patient experience and provider experience [35]
"fairness in processes, outcomes, and relative costs" [2]
Better-quality education [36]
Peters (2021) Added "family experience" [37]
Aims for digital health entrepreneurship [38]

| 2008 | 2015 | 2018 | 2022 |

2015 Quadruple Aim
Adds fourth aim of Practitioner Well-Being to the Triple Aim definition of Berwick et al [34].

2022 Quintuple Aim (Equity):
Nundy et al [5] Append "Equitable Care" to the scope of Quadruple Aim

Fig. 2: Notions of Quintuple Aim in from the scoping review of the literature.

We found evidence confirming the notion that a learning health system (Table 2) is foundational to achieving the quintuple aim [9; 10], integrating medical, and biomedical knowledge artifacts to improve health in learning health systems. Health delivery organizations, and other settings of the ecosystem [11], especially as a response to the inequities imposed by the COVID-19 Pandemic focused on extending access through telemedicine for pharmacy [12] and pediatrics [13], for instance. Before the COVID-19 Pandemic, the concept of the quintuple aim related to equity as a key health care aim for primary care payment [14], and a guideline for financially sustainable safety net [15]. In 2021, academic works registered an exponential increase in the reference to achieving the quintuple aim through recording case studies in telehealth to improving access to care [16] through at home care for instance [17; 18; 19], while applying technologies of virtual care, which became synonymous to achieving equity, enhancing patient engagement [20] through live and asynchronous consultations [21]. Investments in inclusive primary care research essential for quintuple aim [22], with the use of artificial intelligence (AI) platforms [23] and models that continue to be critical to the advancement of equitable care [24]. High-quality data is critical to healthcare research [25] and essential factor in achieving the quintuple aim [26; 27]. Sociodemographic and clinical data at the individual and the community levels support an improved understanding of the distinct needs of the populations [28]. We clearly observe from the papers and research output, recommendations for explicitly incorporating health care AI for equitable care [29; 30; 31; 32].

Table 2: Evidence on the notion of technology innovations in reaching the Quintuple Aim

Notion	Evidence in the literature
Equity in terms of affordable care	Quintuple aim related to equity as a key health care aim for primary care payment [14], a guideline for financially sustainable safety net [15].
Quintuple Aim for powering learning health systems	Integrating medical, and biomedical knowledge artifacts to improve health in learning health systems [9; 10]. Medical Knowledge for a learning health system [11]. Achieving quintuple Aim through learning health system [12; 13]. Investments in inclusive primary care research essential for quintuple aim [22]. High-quality data is critical to healthcare research [25; 26; 27; 28].
Telehealth and remote patient Monitoring technology to improve access to care	As a response to the inequities imposed by the COVID-19 pandemic focused on extending access through telemedicine for pharmacy [12] and pediatrics [13], to improve access to care [16]. At-home care as example of health equity – enabled by remote patient monitoring and live remote consultations [21]. Applying technologies of virtual care became synonymous to achieving equity, enhancing patient engagement [17; 18; 19].
Explicitly incorporating **Artificial intelligence** platforms for equitable care	Improving equity with the use of artificial intelligence (AI) platforms [23] with models that continue to be critical to the advancement of equitable care [24; 30].

3   Discussion

3.1   Equity and Quality Full Circle

Notions that we have identified explicate the varied conceptualization of the fifth aim and underscore the importance of Equity in care for Health Care Improvement and providing Quality care. Our scoping review shows a progression of multiple variations of the Quintuple Aim concept. These iterations reassembled a five-aim model in multiple contexts; some include provider experience [35], students' and teaching staff experience [36], family experience [37] workforce engagement, and safety [38], and care business processes [11]. Fiscella and Carroll [14] considered the notion of "equity in care" as "fairness in processes, outcomes, and relative costs". Lastly, in 2022, Nundy et al [5] connected the Quintuple Aim for Health Care Improvement to the 6 Aims for Quality care – thus adding a 5th aim of health care improvement where "*no one is disadvantaged due to social position or other socially determined circumstances*". The description echoes to the definition of Equitable Care in the model of Quality Care [1] and referenced the social determinants of health, stating that "*Providing care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographic location, and socioeconomic status*". These iterations reassemble a five-aim model in multiple contexts, to underscore the importance of equity in care for health care improvement and providing quality care. With that we have come a full circle to map the aims of to the six aims of quality care [39; 1], resulting in a Quintuple Aim for improving Healthcare system performance.

3.1   In Practice

The literature was specific about the fact that practitioners have signed up to this five-aim framework, recognizing that, "*going forward, the issue will be to ensure that broadband availability and access to potentially transformative technologies are scalable and sustainable so that we can meet patients and clinicians where they are*" [28]. It will also be critical to find ways to employ technology to test for social issues and/or give nonmedical "health care" or non-acute assistance that can facilitate health services at home while simultaneously reducing social isolation and providing support to our aging population. Assessing a practice's ability to achieve the triple (or quadruple or quintuple) aim means looking at specific measures for each aim [40]. Improvements in health care financing, care allocation, language translation availability, community-based care, cross-cultural health professional education, and data gathering and research activities are among the recommendations. Operational outcomes measure are developed and applied to capture the attainment of the five aims. Patient Experience or Patient Satisfaction, Staff Experience; Staff burnout surveys capture and trend the experience; utilization and risk adjusted utilization models are used to assess accessibility and better outcome (usually tracked by number of patients per month or per year) can include primary care physicians visits, specialty referrals, high-cost imaging (MRI, PET, etc.)[4]. Public health practitioners track per capita costs (per 1,000 patients) or total

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[4] https://blog.ncqa.org/risk-adjustment-utilization-tables-new-format-new-resource/

costs of care through metrics of emergency department use, hospitalizations, ambulatory care, etc. while incorporating measures of health disparities and social determinants of health (e.g. PRAPARE survey).

3.2 Transforming our Care System into a Self-learning Health System

The literature emphasized that a learning health system is foundational to achieving the quintuple aim [12; 13; 9; 10], integrating medical and contextual knowledge for an equitable health system [11]. The idea of learning is particularly important for so-called "intelligent" systems that may be able to self-reconfigure in order to resist / persist over time. While adapting and continuously altering, learning health systems examine how environmental, policy, and system level activities will influence the social determinants of health of individual population groups and modify practices to influence their health behavior [41]. This leads to the non-optional transformation of the care ecosystem into a self-learning system using technology, data and analytics to maximize the value and equity of care. Solutions such as Artificial intelligence (AI) and Virtual Health (Telehealth) support the healthcare system in achieving healthcare equity (Table 3) by closing care gaps extant in current care models and hence ensuring continuity of care [42].

Table 3: Concepts from the literature connecting the quintuple aim to Digital Health

Artificial Intelligence (AI)
- AI mitigates health inequities - partnerships between Physicians and technologists [23]
- AI models continues to outpace adoption for quality care and equity [24]
- Provide multidisciplinary developmental science teams with expertise in cognitive development, medicine, psychology, computer science, and medical informatics [29]
- AI an essential factor in achieving the quintuple aim of health care driving change in knowledge integration through the society [26]
- AI importance to the realization of the learning health care system through modelling work processes, culture, equity, patient–provider relationships, etc. [30]

Virtual Care or Telehealth (TH)
- Robust, comprehensive telehealth coverage is critical to improving pediatric access and quality of care and services, particularly for under-resourced populations [16].
- Telehealth for at home Care [17]; Pediatrics [18] and specialty care at a distance [21]

3.2.1 Artificial Intelligence (AI)

The literature was explicit in discussions of health care Artificial Intelligence (AI) for equitable care [29; 24; 26; 27]. Artificial intelligence (AI) which "*refers to the capacity of computers or other machines to exhibit or simulate intelligent behavior*" (Oxford English Dictionary[5]) has occupied a large presence in the practice of care and enabled its transformation to settings outside the hospital and clinic [31]. Investments in inclusive primary care research essential for Quintuple Aim [22]. AI in primary care [23], is

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[5] SOURCES: Oxford English Dictionary; Witten, I. H., E. Frank, M. A. Hall, and C. J. Pal. 2016.

an essential factor in achieving the quintuple aim of health care [27]. By working with technologists to make sure that AI use cases are pertinent and human-centered, incorporating quality improvement techniques into health care AI implementations, and promoting inclusive and moral AI that mitigates rather than exacerbates health inequities, PCPs can advance the field of artificial intelligence in medicine [23]. High-quality data critical to healthcare research and quintuple aim [25]. Notably, in support of adolescent health, underscoring the need for multidisciplinary developmental science teams with expertise in cognitive development, medicine, psychology, computer science, and medical informatics [29]. The ability to collect and analyze data for evidence-based approaches to achieve equity would be an equalizer if utilized safely, carefully, and with good intentions. If enough patients from the society provide data to these data analyses, the advances outside of the inequitable clinical research field could help to bridge the existing research equity gap. AI has disrupted healthcare on many fronts. On the individual level for better personal health, to augment primary care outside of the clinical encounter, or devising population health strategies for improving medication adherence [32]. Sociodemographic and clinical data at the individual and the community level to better understand the distinct needs of the populations [28]. The application of AI can evaluate enormous amounts of data maintained by healthcare organizations in the form of digital scans, clinical research trials, and medical claims, and can spot patterns and insights that are typically missed by humans. In order to reduce health inequities, well-trained AI systems can lessen or eliminate potential prejudice through encouraging data transparency and diversity. AI research in healthcare offers the potential to reduce disparities in health outcomes based on race, ethnicity, or gender.

3.2.2   Virtual Health (Telehealth)

The body of literature connects Telehealth to achieving the quintuple aim for telehealth for at home Care [17], in pediatrics [16; 19], improving access to care [18], sometimes through asynchronous consultation [21], enhancing patient engagement during virtual care [20]. Care for kids with severe chronic illnesses is becoming an expanding part of pediatric practice. Providers and health care systems can administer direct care, assure continuity of care, coordinate indirect care, and enable various non-medical services affecting children with complicated medical needs using telehealth [18]. Cahan et al [18] discuss considerations including judiciousness, acceptability, design, interoperability, effectiveness, dissemination, cost-effectiveness, adaptability, monetizability, and security can help ensure equity amid the further implementation of telehealth serving pediatric populations. It is remarkable, how the breadth of specialty services offered at a distance, has greatly expanded beyond dermatology and includes cardiology, nephrology, and hematology [21]. Other applications for remote monitoring patient progress in isolated countryside areas can be connected through telemedicine systems for measurements of vital indicators (pressure, sugar, etc.). These are then integrated to citizens medical records for advice from the hospital / health center doctors [42]. Increased social isolation can have negative effects on health outcomes. Interventions designed to mitigate the effects of isolation such as the facilitation of the presence of informal social

supports including extended family, neighborhood and community resources have potential to improve health care outcomes [20].

4 Technology for Equity in Healthcare Service Systems

The concept of accessibility, "the ease with which people can reach places or opportunities", lies at the heart of what makes cities equitable and sustainable [48]. To be equitable, health systems must use technology to combine various infrastructures and services to take advantage of the integration of knowledge and the refinement required for the transformation and development to facilitate the ability to integrate, create and reconfigure both internal and external competences to manage knowledge that originates from within and beyond the ecosystem boundaries.

A digital health system is an essential foundation to achieve the quintuple aim [10]. A developing care practice's main approach is to use predictive modeling with AI tools in conjunction with evidence based best practices, enabled by telehealth and other access technologies, to achieve and maintain population level health gains [20]. For example, every encounter generates data, which when merged with existing data and analyzed by practitioners, becomes key to emphasize currency, relevance and equity in the delivery of care.

The expected health system impacts are those established by the quadruple aims that include all the actors in the health ecosystem. Such aims address improving patient and caregiver experience; improving the health of populations; reducing per capita cost; and improving the work life of providers. Therefore, knowledge integration through technology actors such as telehealth and artificial intelligence, power the cyclical resource integration that emphasize the fifth aim of equity in the healthcare ecosystem for the realization of the quintuple aim [49]. New knowledge gained in one cycle is subsequently applied to all future contacts in the form of forecasts and actionable suggestions. The cycle of knowledge transformation creates a type of Information Common Goods that aid in the democratization of information and its availability for sustainability long-term societal growth [50]. As a result, such models of learning health systems must account for improving care to demonstrate value, investing in infrastructure to enable enhanced care, and building and leveraging partnerships that fuel continuous knowledge exchange to achieve health disparity reduction [14].

5 Conclusion and Further Research

With this review we do not claim to draw definitive conclusions for practice, rather an understanding of the evidence of use of the expression of Quintuple Aim and the extent to which this stream of research have framed the fifth aim of Equitable Care. We took note of the evolving conceptualization of aims for improving healthcare system performance. Through a temporal analysis of the literature instances found, it is clear that the concept of the quintuple aim for healthcare is recent and the reference to add equity to the quadruple aim is to include Equity is new (with an increasing literature record since 2018) and still limited, but growing exponentially.

Though the concept of the quintuple aim is nascent, the notion significantly connects to the social determinants of health as components in planning for health system improvement. Our review isolated digital health technologies such as AI and virtual health (Telehealth) as essential means to achieving the quintuple aim.

Digital technology is making healthcare proactive rather than reactive, expanding and enabling access to quality healthcare for previously underserved or marginalized areas, treating the right patient at the right time and the right place [44]. In the future, digital healthcare will enable the delivery of value-based care while also enhancing health and yielding real results. It may even pave the road for universal healthcare to become a reality. Our work provides a basis for further research in digital health that align service provisioning and delivery to "*Equity*" as value delivered from a smart healthcare ecosystem. The potential for applying artificial intelligence (AI) models to proactively plan, implement, and monitor the extraction of insights from healthcare data to enhance health care outcomes, affordability, and patient experiences is available to practitioners. Health care organizations, whether large and small, must enhance their data management procedures and develop the skills that support them in order to take advantage of these data [45]. In this case, while AI is essential to service provisioning, virtual health (Telehealth) is indispensable in service delivery for equitable care addressing shortcomings in more traditional in-person interactions between clinicians and patients, becomes important [46]. These measures for inclusion contribute to models of health equity, for a better future of care [47].

In the future, digital healthcare will enable the delivery of value-based care while also enhancing health and yielding real results. It may even pave the road for universal healthcare to become a reality.

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