Embracing complexity: applying complexity theory in dental hygiene practice

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Key points		
By introducing complexity theory, readers gain a conceptual toolkit for responding flexibly to unpredictable clinical scenarios, particularly where patient factors don't fit textbook patterns.	The paper moves practitioners away from rigid protocol adherence toward approaches that better respect each patient's unique needs, constraints, and social context.	Readers benefit from a rare synthesis of conceptual theory and grounded practice, helping to make complexity theory relevant and usable, not just academic.

Abstract

Contemporary dental hygiene practice has evolved into a complex intersection of clinical care, behavioural science, and systemic health management, yet traditional linear frameworks struggle to capture this multifaceted reality. This narrative examination explores how complexity theory, particularly complex adaptive systems, offers dental hygienists a more authentic lens for understanding and navigating the unpredictable, interconnected nature of modern healthcare.

Drawing from systems thinking and real-world scenarios, we examine complexity theory's applications across clinical decision-making, professional identity development, interprofessional collaboration, and education. Through cases ranging from managing periodontal disease with comorbidities to designing adaptive community programmes, this exploration reveals how embracing uncertainty and interdependence enhances effective practice.

Complexity-informed dental hygienists develop enhanced capabilities for adaptive reasoning, collaborative leadership, and context-sensitive care. Educational implications include curricula fostering epistemic flexibility and systems thinking, while organisational considerations emphasise policy frameworks supporting distributed leadership and iterative innovation.

Instead of viewing complexity as a challenge to overcome, this examination positions it as healthcare's fundamental characteristic requiring skilled navigation. For dental hygienists, embracing complexity theory represents an opportunity to contribute meaningfully to healthcare transformation and a responsibility to develop adaptive expertise for 21st century practice.

Introduction

Dental hygiene in the United Kingdom is undergoing a significant evolution. In recent years, hygienists have gained greater autonomy through direct access, independent use of local anaesthesia, and integration into interdisciplinary teams.[1] This shift reflects more than regulatory change – it marks the profession's emergence as a provider of comprehensive preventive and therapeutic care.[2]

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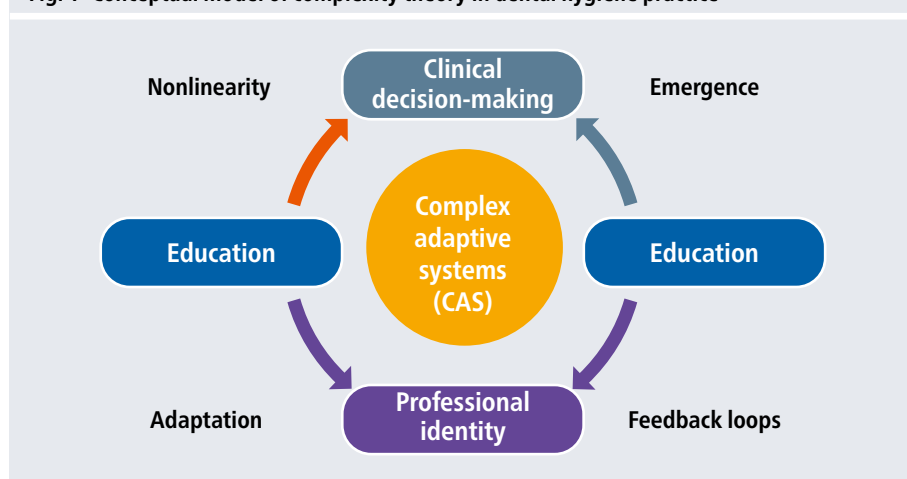*Correspondence to: John Stanfield
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At the same time, oral health is increasingly recognised as shaped by a web of interdependent factors. Systemic disease, psychosocial stress, and social determinants interact in ways that influence both disease and outcomes.[3] The COVID-19 pandemic underscored this complexity, revealing the limits of rigid care pathways and the need for adaptive responses.

Traditional models often follow linear, reductionist logic: isolate a problem, apply a solution, expect a predictable outcome. Yet, dental hygiene practice reveals something different. Patients present not as isolated cases but as individuals embedded in complex, dynamic systems. Periodontal disease intersects with diabetes; health education connects with literacy and socioeconomic status; and routine appointments may uncover safeguarding or mental health needs.

Increasingly, healthcare systems are recognising such complexity. Complexity theory offers a framework for understanding interdependencies, emergence, and adaptation at both clinical and organisational levels.[4,5] While dental hygiene has long been framed as routine, new perspectives suggest it is ideally placed to benefit from complexity-informed thinking, integrating systems approaches, evidence-based management, and behavioural change frameworks, such as the Theoretical Domains Framework.[6,7]

Rather than eliminating uncertainty, complexity theory embraces it, highlighting how real-world care involves feedback loops, non-linearity, and constant change. This article explores how complexity theory informs clinical care, identity, collaboration, and education in dental hygiene, equipping practitioners with conceptual tools to navigate the realities of 21st century healthcare.

Fig. 1 Conceptual model of complexity theory in dental hygiene practice

Understanding complexity theory and its evolution in healthcare

Origins and relevance

Complexity theory arose in contrast to reductionism, emphasising how wholes exceed the sum of their parts. Early studies, like Lorenz's work on deterministic non-periodic flow, explored sensitive dependence on initial conditions.[8] However, unlike chaos theory, which describes systems on the edge of unpredictability, complexity theory in healthcare concerns itself with systems that adapt and self-organise.

A complex adaptive system (CAS) is one where multiple interacting agents adapt based on internal and external feedback, leading to emergent patterns without a central controller (Fig. 1).[9] Examples include ecosystems, economies and healthcare systems.

Core features

- Non-linearity: effects are not always proportional; small actions can have large or negligible impacts
- Emergence: outcomes arise from interactions, not predictable from individual elements
- Lagged feedback: important in healthcare – interventions may initially appear ineffective or detrimental before later benefits emerge. As Senge describes, 'things get worse before they get better', due to delayed system adjustments[10]
- Adaptation and learning: agents change behaviour over time in response to experience
- Distributed control: no single person or policy entirely directs the system; order evolves through local decisions.

Linking theory to practice

In healthcare, these principles reveal why standardised pathways may falter. For example, feedback from frontline practice during the pandemic rapidly altered guidelines, illustrating lagged and iterative system responses.[11,12] For dental hygienists, recognising their work as part of a CAS reframes uncertainty as an expected, even necessary, aspect of care.

Relevance to dental hygiene practice

Clinical decision-making

Dental hygienists encounter complexity daily, particularly in managing periodontal disease, which reflects interactions among biofilm, immune responses, systemic health, behaviours, and social factors. A purely mechanical focus on calculus removal overlooks these intertwined influences.

A complexity-informed approach entails:

- Assessing the patient's broader health context, such as diabetes or medication impacts
- Recognising stress and life events as modifying disease progression and treatment adherence
- Adapting plans based on healing patterns, acknowledging lagged feedback – initial deterioration may precede improvement
- Co-producing flexible care strategies with patients, adjusting as their circumstances change.

For instance, a patient recently made redundant may face increased stress, dietary changes, and defer dental visits. Viewing this through a CAS lens encourages exploration of these links rather than attributing non-adherence solely to motivation.

Patient education and behavioural change

Patient adherence is notoriously difficult to predict. Behaviour change models like the COM-B (capability, opportunity, motivation-behaviour model) acknowledge that capability, opportunity, and motivation interact in complex ways.[13] Complexity theory further enhances this by recognising feedback loops: success in one area (e.g., reduced bleeding on brushing) can reinforce behaviour, while failure can create negative spirals. This aligns with findings by Hrisos *et al.*, who demonstrated the value of psychological theory in predicting and shaping healthcare professional behaviour.[14]

Dental hygienists are ideally placed to use brief interventions, motivational interviewing, and iterative care plans – practices that resonate strongly with CAS principles.

Case examples

Managing periodontal disease with co-morbidities

A 58-year-old patient presents with uncontrolled diabetes, generalised stage III periodontitis, and high levels of occupational stress. Under a reductionist approach, the focus might remain on mechanical debridement. However, a complexity-informed dental hygienist would:

- Collaborate with the general practitioner (GP) or diabetic nurse to monitor glycaemic control
- Use motivational interviewing to explore stress coping strategies
- Adjust recall intervals flexibly based on healing patterns
- Consider the patient's work schedule when planning reviews.

The treatment evolves through trial, reflection and adjustment. This is not a failure of planning – it is a hallmark of complex systems thinking.

Managing paediatric caries in a family context

A seven-year-old child presents with early childhood caries (ECC). The child's parents are struggling with time constraints, both working full-time, and there are concerns about the child's diet and oral hygiene routine. Under a reductionist approach, the focus might simply be on immediate restorative treatment for the child's teeth. However, a complexity-informed dental hygienist would:

- Assess the broader family context: the child's home environment, parental work schedules, and how these affect the child's oral health
- Engage in family-centred care, having discussions with parents about realistic, sustainable changes to improve oral hygiene and diet
- Collaborate with the school to establish a supportive environment for promoting oral health, such as incorporating brushing routines into daily activities
- Monitor progress through frequent reviews, adjusting the intervention as needed based on how the family adapts to the recommendations.

This approach illustrates how the dental hygienist recognises that multiple factors influence the child's oral health and the solutions must evolve as these factors change.

Implementing complexity thinking in daily practice

Dental hygienists can integrate complexity principles into routine practice through straightforward adjustments to existing workflows and decision-making processes. These applications require no additional resources but can significantly enhance patient outcomes and professional satisfaction.

The 'systems check' approach

Before treatment planning, ask three complexity-informed questions:
- Interconnections: 'what other factors might influence this patient's oral health?' (medications, stress, housing, work patterns)
- Feedback loops: outcomes influence future actions through reinforcing or dampening mechanisms, often with delays (lagged feedback) where effects may take time to become evident, reflecting Senge's notion that interventions can initially appear to worsen outcomes before improvements emerge[10]
- Adaptation: 'how can I build flexibility into this care plan to respond to changing needs?'

Example: a patient presents with gingivitis and mentions recent job loss. A complexity approach considers how unemployment stress, potential diet changes, and reduced healthcare access might influence treatment success, leading to a more supportive, adaptable care plan.

The 'pause and pivot' technique

When standard approaches aren't working, use complexity principles to reframe:
- Pause: acknowledge that linear solutions may be insufficient
- Explore: ask 'what else is happening in this person's life?'
- Pivot: adjust approach based on emerging information

Practice application: a patient consistently misses appointments despite apparent motivation. Rather than increasing pressure, explore work patterns, childcare responsibilities, or transport issues, then co-create solutions.

Building feedback loops

- Regular micro-check-ins: 'how is this working for you?' during treatment
- Follow-up calls: brief calls between appointments to adjust care plans
- Patient-led assessment: encourage patients to report what's helping or hindering their progress.

Complexity and professional identity

The professional identity of dental hygienists itself evolves within a complex system. It is shaped by interactions with patients and teams, the capacity to envision new roles, and alignment with shifting regulatory and organisational landscapes:[15,16]
- Engagement: direct involvement in multidisciplinary care, such as managing periodontal health jointly with diabetes nurse specialists, reshapes professional self-concept from 'oral cleaner' to integral systemic health contributor
- Imagination: envisaging new possibilities, like influencing local public health initiatives or incorporating digital scanning workflows, expands professional horizons
- Alignment: structural changes, such as direct access policies and NHS (National Health Service) preventive commissioning targets, reinforce and adapt professional identity, but often through feedback loops rather than direct mandates.[17]

Like any CAS, identity formation involves continuous, non-linear adjustments in response to practice realities, patient needs and policy shifts.

These shifts are rarely the result of top-down mandates alone; rather, they emerge through feedback loops between policy, practice and professional self-concept.

In sum, the professional identity of dental hygienists can be seen as a complex adaptive process, emergent, self-organising, and responsive to both micro-level interactions and macro-level systemic changes. Through ongoing engagement, the capacity to imagine new futures, and alignment with evolving institutional norms, the profession's identity continues to be co-constructed.

Educational implications

To practise effectively within complex adaptive systems, dental hygienists must cultivate more than technical competence. They require epistemic flexibility, or the capacity to navigate uncertainty, ambiguity, and shifting patient contexts without rigid adherence to protocols. Bleakley[18] argued that uncertainty is not a problem to be eliminated but a pedagogical resource – an opportunity to foster deeper critical thinking and adaptive expertise. Therefore, educational programmes must move beyond reductionist curricula that treat clinical problems as isolated, solvable puzzles and instead embrace real-world practice's messy, relational nature.

Teaching systems thinking with visual mapping

Traditional dental hygiene education often compartmentalises clinical knowledge into discrete subjects (e.g., periodontology, radiography, pharmacology). In contrast, systems thinking encourages learners to perceive patterns, relationships and feedback loops across domains. For example:
- Students might be introduced to causal loop diagrams or rich pictures to visually map the interconnections between oral health and wider social determinants, such as income, housing, mental health and access to care
- A classroom activity could involve mapping the multiple stakeholders influencing an oral health outcome for an older patient in a care home – dentist, GP, carer, family, social worker – highlighting where bottlenecks, leverage points, or communication failures occur.

This kind of exercise cultivates a mindset that seeks not linear answers but relational understanding.

Embedding reflective practice and ethical reasoning

Reflective practice becomes essential in complex systems where actions cannot always be predicted to yield consistent results. It enables practitioners to make sense of outcomes retrospectively and adjust future behaviours. Reflective practice, as articulated by Schön, and the principles of educational best practice, described by Oermann, provide a pedagogical foundation for developing adaptive, complexity-informed curricula.[19,20]

- Example: students could be asked to journal their responses to ethically ambiguous scenarios, such as a patient refusing treatment, that the student believes is clinically essential and discuss the underlying tensions in peer groups
- A module might present conflicting obligations: balancing a patient's autonomy with safeguarding concerns or deciding whether to challenge a colleague's inappropriate behaviour during professional mechanical plaque removal when the patient is present.

These activities build moral resilience and support ethical reasoning in the face of conflicting priorities and emotional challenges.

Simulating real-world complexity in clinical training

Rather than idealised case studies where the 'correct' intervention is clear, learners should be exposed to messy, ambiguous cases that mirror clinical reality. This fosters adaptability, improvisation, and context sensitivity.

- Case example 1: a young refugee patient presents with generalised gingivitis. The patient has limited English, no fixed address, and is anxious about authority figures. The student must coordinate with interpreters, understand trauma-informed care, and develop a prevention plan that accounts for housing insecurity
- Case example 2: a patient with a learning disability attends with their carer. The carer dominates the consultation and insists on specific treatment. The student must navigate issues of consent, advocate for the patient, and work within the patient's and carer's understanding of oral health priorities.

These scenarios resist simplistic resolutions and require learners to weigh priorities, adapt communication strategies and reflect on how their biases shape decision-making.

Reframing the role of the educator

In a complexity-informed curriculum, educators move from transmitting knowledge to facilitating learning through uncertainty. Rather than shielding students from ambiguity, they help them navigate it. Assessment shifts towards reflective portfolios, collaborative problem-solving, and case-based learning over time.

Ultimately, complexity theory reframes dental hygiene education as transformational. The goal is not just technical competence, but the development of reflective, adaptable professionals equipped to respond with integrity and compassion to the unpredictability of real-world care.

Organisational and policy considerations

To foster complexity-resilient dental hygiene practice, healthcare organisations and policymakers must create environments that enable adaptability, collaboration, and emergent innovation, rather than reinforcing rigid hierarchies or prescriptive models of care. Complexity theory encourages systems to evolve through feedback, learning and local responsiveness – features that must be mirrored in institutional structures.

Key organisational strategies
Promoting distributed leadership
Dental hygienists should be empowered to contribute meaningfully to leadership beyond clinical care. This includes:

- Leading clinical audits focused on periodontal outcomes or fluoride application rates
- Participating in or chairing quality improvement initiatives that address access, equity, or patient safety
- Supporting the development of evidence-based clinical pathways, particularly in prevention-focused care.

These contributions allow leadership to emerge organically from within teams, rather than being top-down. Distributed leadership supports the idea of self-organisation, a key feature of complex adaptive systems.

Aligning policies with practice
Complexity theory highlights the importance of coherence between policy frameworks and frontline realities. A clear example is the issue of direct access:

- The General Dental Council[1] reaffirms that dental hygienists and therapists can see patients directly, without a dentist's prescription, provided they are confident working within their scope of practice and competence
- However, NHS commissioning structures in many regions do not yet fully support this autonomy. Direct access is technically permitted, but funding models may still require dentist-led sign-off for remuneration, creating a disconnect between regulatory permission and practical delivery
- Similarly, job descriptions in NHS or Community Dental Services may remain dentist-centric, underutilising hygienists' potential to lead on prevention, behavioural change, or long-term periodontal maintenance.

A complexity lens helps stakeholders move beyond blame or inertia by recognising that policy, professional behaviours, and outcomes are interdependent. Misalignment in one area disrupts the functioning of the whole system.

Limitations

This conceptual analysis presents theoretical propositions rather than empirically tested interventions. Future research should investigate the practical implementation and effectiveness of complexity-informed approaches in dental hygiene practice through controlled studies and longitudinal observation.

Conclusions

This narrative highlights complexity theory as more than an abstract concept; it offers a practical framework for dental hygienists navigating an evolving profession. Rather than viewing unpredictability and interconnectedness as obstacles, this perspective reframes them as opportunities to enhance patient care and professional growth.

Three key insights emerge. First, effective clinical decisions arise from adaptive, context-sensitive responses rather than rigid protocols. Second, professional identity is shaped through active engagement with complexity, not by avoiding uncertainty, but by navigating it. Third, educational strategies that foster systems thinking and ethical reasoning better prepare practitioners for challenges traditional curricula cannot anticipate.

The implications extend beyond individual practice to systemic transformation. Complexity theory aligns policy, education and clinical care by positioning dental hygienists as adaptable professionals capable of driving innovation. With expanded scopes of practice, a renewed focus on prevention and a post-pandemic emphasis on resilience, this is a timely opportunity for complexity-informed leadership.

Realising this potential requires stepping beyond familiar routines. It demands openness to ambiguity, collaboration, and lifelong learning. Above all, it means recognising that complexity is not a problem to solve but a condition to embrace.[21] For those willing to do so, the reward is a greater clinical impact and a meaningful role in shaping a more responsive and sustainable future for oral healthcare.

The narrative is still being written, one complexity-informed interaction at a time.

Ethics declaration
The author declares no conflicts of interest.

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