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A consensus-based agreement on a definition of a process variable: findings from a New Zealand nominal group technique study

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Abstract

Background Musculoskeletal pain and disability are leading causes of reduced health and significant economic costs worldwide. Individualised, and evidence-based treatment approaches for specific musculoskeletal conditions aimed at improving patient outcomes and costs have not been successful. Recently authors have suggested that the 'process' of how care is implemented within a health system needs to be considered as an influencer on patient outcomes. With the rising prevalence of musculoskeletal conditions and the burgeoning costs associated with their treatment, it seems timely that new research focusing on process variables and their influence on patients with musculoskeletal conditions is explored. Before such studies can take place, a modern definition of a process variable within a musculoskeletal care pathway is needed to anchor future research endeavours. Therefore, the aim of this study was to establish a consensus-based definition of a process variable within a musculoskeletal care pathway, based on a New Zealand setting.

Methods This study used a virtual nominal group technique and took place in July 2023 using a Microsoft Teams platform. A nominal group technique employs a structured approach to generate information and solutions to problems that can then be prioritised through group discussion and consensus. It is unique because it allows expert participants to explore using in-depth inquiry, areas previously unidentified or not yet investigated. There was an inclusion criterion and the participants completed pre-work before the two-hour five stage virtual meeting. The Auckland University of Technology Ethics Committee (AUTEC) approved this study (AUTEC 23/94).

Results The study included eight participants (five male, three female) who had extensive experience with the New Zealand ACC insurance scheme and the design, implementation, and administration of musculoskeletal care pathways. The consensus definition was '*A health process variable is any modifiable factor in a health process or pathway that can be quantified and measured and that if varied may achieve a different operational or patient outcome*'.

Conclusions This study of New Zealand-based experts has formed a consensus-based agreement for a definition of a process variable in a musculoskeletal care pathway. This is an important first step in developing our understanding of process variables, and further research is needed to establish the link between process variables and their influence on the outcomes of patients with musculoskeletal conditions.

Keywords Process variables, Healthcare, Musculoskeletal conditions, Nominal group technique, Care pathway

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Background

Musculoskeletal (MSK) health is essential for human function and quality of life [1]. MSK-related pain and disability are leading causes of reduced health and significant economic costs worldwide [2–6]. In 2019, MSK conditions comprised 17% of global years lived with disability (YLDs) [7]. The prevalence and impact of MSK conditions will continue to rise, as most painful MSK conditions are associated with an increase in age, other comorbidities (i.e., obesity, diabetes), and reduced activity levels [1, 4, 8].

To improve MSK patient outcomes, researchers and clinicians have historically focused on improving diagnosis and on the implementation of diagnosis-informed individual treatment approaches for MSK conditions [9–12]. Unfortunately, the focus on diagnostics has contributed to the increasing resource utilization for MSK conditions and does not appear to have improved outcomes [13]. Similarly, individualised, and evidence-based treatment approaches for specific MSK conditions aimed at improving patient outcomes and costs have not led to any dramatic improvement in disability levels or patient outcomes [4, 9, 14, 15]. These failed attempts to influence patient outcomes have led to some researchers suggesting that elements other than diagnosis and clinical factors may have a greater effect on outcomes [16–18].

It has been suggested that the 'process' of how care is implemented within a health system needs to be considered as an influencer on patient outcomes [19, 20]. It is thought that health systems that have processes in place that facilitate the movement of patients through a care pathway in a timely and organised manner will more likely have better results [20–23]. There has been a recent focus on strengthening and improving the MSK care pathway and health systems worldwide to match the unmet need for the rehabilitation of musculoskeletal conditions [24, 25].

A process variable within a health system or care pathway was first described as a factor that precedes the assignment of a treatment and has the potential to influence or affect the patient outcome by interacting with the treatment variable [26, 27]. An example could be time taken for a patient to first receive an assessment or treatment. Brennan et al. (2015) performed a retrospective analysis ($n=328$) of electronic health data to evaluate outpatient care following total knee arthroplasty (TKA) and reported that variables related to the process of providing outpatient care were significant predictors of clinical outcomes following TKA. It was found that fewer days between discharge as an inpatient to the initiation of outpatient clinic-based physical therapy was significantly correlated with lower pain and higher functional levels at the completion of outpatient rehabilitation [28]. Other than the work of Brennan and colleagues, there is limited research investigating process variables within MSK care pathways. Furthermore, there also does not appear to be agreement of what variables should be considered process variables in a health care setting [29].

Currently, health care systems around the world use different approaches to manage the growing burden of musculoskeletal conditions and disorders [1, 30, 31]. In New Zealand, most MSK accidents and injuries are covered and managed by the 'no fault' Accident Compensation Corporation (ACC) scheme that allows claimants access to a range of compensation and rehabilitation entitlements [32–34]. There has been a recent focus by ACC on redesigning and implementing new treatment pathways with enhanced processes in an attempt to improve patient outcomes [35, 36]. In 2022, the ACC rolled out the Escalated Care Pathway (ECP), in which patients follow an integrated and coordinated system designed to provide the right treatment at the right time and to move them smoothly from injury through to recovery [35, 37].

With the rising prevalence of MSK conditions and the burgeoning costs associated with their treatment, it seems timely that new research focusing on process variables and their influence on patients with MSK conditions is explored. Before such studies can take place, a modern definition of a process variable within an MSK care pathway is needed to anchor future research endeavours. Knowing what a process variable is within a health care system will enable research that explores the influence of such variables on patient experiences, outcomes, and costs. Therefore, the aim of this study was to establish a consensus-based definition of a process variable within an MSK care pathway.

Methods

Study design

This study used a virtual nominal group technique (vNGT) and took place in July 2023 using a Microsoft Teams (Microsoft Corporation, 2017) platform. A nominal group technique (NGT) employs a structured approach to generate information and solutions to problems that can then be prioritised through group discussion [38]. It obtains qualitative information from target groups that are closely associated with a problem area. An NGT is unique because it allows participants to explore using in-depth inquiry areas previously unidentified or not yet investigated [39]. It uses collaborative discussion of immediately formed individual viewpoints and allows minority perspectives to be equally heard before reaching a group consensus [38, 40]. An NGT can be carried out face to face or online (virtual NGT) and is seen as a time efficient, cost effective and efficient decision-making approach [38, 40, 41]. The Auckland University

of Technology Ethics Committee (AUTEC) approved this study (AUTEC 23/94) and it was conducted in accordance with the Declaration of Helsinki [42].

Participant inclusion criteria and selection

For inclusion in this study, participants needed to have recognised expertise and considerable experience (>10 years) in the design, administration, management and/or clinical delivery of MSK care pathways in New Zealand and/or overseas.

Participants were purposively recruited from the database of providers and administrators from Careway, an ACC ECP provider of MSK care based in the upper North Island of New Zealand. An independent administrator employed by Careway contacted potential participants with information about the study to reduce researcher bias or coercion. Additionally, an advertisement about the vNGT study inviting suitable participants was placed on the social media platforms LinkedIn and Facebook by the primary researcher.

The recommended size of an NGT group is five to nine participants [38]. Ten participants initially applied to be included, of which eight of the applicants met the inclusion criteria and gave written informed consent to participate in the vNGT.

Study procedure

Prework

Two weeks prior to the vNGT, participants were given information about the process and asked to consider the question *"What is the operational definition of a process variable within a musculoskeletal care pathway or health system?"* Participants were encouraged to enter their definition and examples of process variables into a shared Google document prior to the vNGT to help them prepare to generate a range of thoughts and to facilitate the sharing of ideas in the group discussion stages of the vNGT.

vNGT

A two-hour vNGT was conducted via Microsoft Teams. The moderator was the primary author who has extensive experience in the design and delivery of services in MSK care pathways. A vNGT followed the five-stage protocol of Potter et al. (2004) and was previously described by Cook et al. (2023). In summary, the stages included:

1. A welcome and introduction of the participants to each other and an explanation of the purpose and procedure of the vNGT workshop.
2. The question (as detailed above) was restated to the participants, and they were given time to add to the shared Google document that they had previously been given access to. During this stage, all participants were asked not to consult or discuss with each other.
3. Next, each participant introduced their initial definition and examples of factors they considered to be process variables that they had contributed to the Google document (Table 1). This document was shared on the screen so that all participants could see the list in real time. No debate or discussion occurred during this stage; however, participants were encouraged to modify their own contribution to the Google document as they listened to other participants if they so wished.
4. Once all participants had spoken, group discussion was encouraged so that participants could seek explanations or further details about any ideas that were produced during the sharing ideas stage. The moderator ensured that all participants were able to contribute to the discussion and that too much time was not spent on any one idea. Participants were encouraged to suggest new items for discussion or thoughts on how to combine ideas to enhance individual definitions. The use of the Microsoft Teams chat function was also encouraged for participants to discuss mutual ideas or conflicts directly with other participants. Each participant "owned" their individual definition and only edited their definition if they agreed to a change suggested by other participants. Following the method of Cook et al. (2023), participants were given two days following the completion of the vNGT online session to modify or delete their own contributions and to suggest edits to other definitions (Table 2). This additional time allowed participants to collect their thoughts and refine their definitions individually.
5. The final stage of the vNGT was to allow the participants to 'rank order' the definitions generated in the previous stage (Table 2). Participants were emailed a link to a Qualtrics survey form that included a ranking function. This form included all seven definitions, and participants could identify their order of preference from their top choice (rank number 1) to bottom choice (rank number 7).

Results

Participant characteristics

The vNGT included eight participants (five male, three female) with a mixture of non-clinical (two had system design and two had business development backgrounds) and clinical (four were physiotherapists) backgrounds. All participants had extensive experience with the New Zealand ACC insurance scheme and the design, implementation, and administration of MSK care pathways.

Table 1 Participant background and initial process variable definitions

Participant	Background	Initial process variable definition
One (non-clinical background)	Physiotherapy business owner/manager 13 years. Health contracts manager 3 years. Health regional manager 2 years. Chief technology officer/founder health business 3 years.	In the context of a care pathway or health system, a process variable can be operationally defined as a measurable or observable factor that relates to the delivery of healthcare services or the implementation of a care pathway. It refers to a specific aspect or element of the healthcare process that can be quantified, monitored, or assessed to evaluate the performance, quality, or effectiveness of the system.
Two (clinical background)	Physiotherapist. Over 18 years' experience based primarily in the public health system. Roles include professional leadership, allied health unit manager, physiotherapy manager, clinical coordinator of community rehabilitation and MSK expert & project facilitator.	A variable that is any structured procedure (generally aimed at enhancing service, improving outcome and/or enhancing cost to benefit) that while receiving a health-related intervention that can influence the outcome of said intervention.
Three (clinical background)	Physiotherapist. Over 22 years of clinical practice, 11 years clinical lead of a specialist orthopaedic spine pathway. Currently physiotherapy consultant and advanced practice and clinical development lead.	An interdependent factor in a clinical care pathway that creates variability in a process measure, moderating one or more clinical and operational outcomes.
Four (non-clinical background)	Over 10 years' experience in operations, engagement and communications within education and healthcare sectors across the UK and NZ, including leading system and process improvements, change management, strategy implementation and delivery.	A change to the current pathway and process which aims to improve current way of doing things including information technology systems to make positive change in the patients' life and enable efficiencies in providers' setting (included operational processes for administration teams).
Five (non-clinical background)	Over 15 years' experience in health management and operations including chief operating officer, strategic programme manager and services manager.	A health process variable is any modifiable factor in a health process or pathway that can be quantified and measured and that if varied may achieve a different operational or patient outcome.
Six (non-clinical background)	Experienced executive with over 30 years in NZ public and private healthcare systems across funding and operational delivery including Director of Elective Services, General Manager of Cardiac and Cancer services, member of expert panels nationally for; population funding, healthcare design and pricing, CEO of clinician-led healthcare company.	A range of processes and inputs that are used to engage, treat, and enable a patient along their pathway to recovery. These are clinical/psychosocial and are modifiable by those engaged in that patients care and return to function including by the patient and their family and employer.
Seven (clinical background)	Physiotherapist. Over 14 years clinical experience working within inpatient and outpatient hospital services, private musculoskeletal practice, and community-based rehabilitation. 8 years' experience as a health researcher. Product Owner to support the design and implementation of Integrated Care Pathways at ACC.	Process factors that are end to end and modifiable across a pathway and are independent of structure and funding and effect outcomes
Eight (clinical background)	Physiotherapist. Clinical practice for 4 years. ACC employee including clinical advisor, team leader, and product manager for 14 years. Product Manager of Health Initiatives at ACC.	Identified factors that might impact processes and outcomes (not necessarily modifiable)

Table 2 Final process variable definitions

Participant	Final process variable definition
One	A process variable is a specific measure which can be quantified and tracked that affects the outcome of healthcare service delivery. Process variables are often associated with the identification and management of bottlenecks or constraints within a system.
Two	A health-related process variable is a process that has an impact on any part of the patient's journey, it is interdependent with the patient and other processes, it is modifiable, measurable, and generally patient centric. One should always consider the effect of modification and change of a process variable on the overall outcomes for the patient.
Three	An interdependent factor in a clinical care pathway that creates variability in a process measure, moderating one or more clinical and operational outcomes.
Four	A health process variable are patient-centric interdependent and modifiable factors that impact current processes and pathways to enhance and improve patient, provider and community engagement and create a change in the system that will have a sustainable impact now and in the future. This includes removing access barriers, improving funding structures, operational efficiencies, technology/systems integration (including real-time information sharing, data exchange, collection), and engagement initiatives.
Five	A health process variable is any modifiable factor in a health process or pathway that can be quantified and measured and that if varied may achieve a different operational or patient outcome.
Six	A range of processes and inputs that are used to engage, treat, and enable a patient along their pathway to recovery. These are clinical/psychosocial and are modifiable by those engaged in that patients care and return to function including by the patient and their family and employer.
Seven/Eight	Process variables are modifiable aspects of the end-to-end patient care pathway that can influence a patient outcome.

Two participants were employees of the ACC insurance scheme and worked in strategic and design roles. One participant had additional experience with MSK care pathways in the public health system of New Zealand, and one participant had additional experience with MSK care pathways in the public health system of a European country (Table 1).

Stage two findings

Each of the eight participants generated an initial definition of a process variable during stage two of the vNGT. Additionally, all participants provided examples of what they considered to be process variables (Table 1).

During the group discussion phase, the participants actively shared thoughts and opinions on process variables, and they were allowed to craft their final individual definitions. The final process variable definition for three participants was unchanged from their initial iteration. At the end of this stage of the vNGT, there were seven definitions (two participants agreed to combine ideas to form a single definition (Table 2).

Final definition

The rank ordering and voting process needed a clear winner (at least one standard deviation mean score over the next best score) from the seven definitions. Definitions five and seven both ranked highly, being placed in the top three by all participants. Once all participants had voted, the final definition had two standard deviation mean scores over the second placed definition and was defined from participant number five.

"A health process variable is any modifiable factor in a health process or pathway that can be quantified and measured and that if varied may achieve a different operational or patient outcome".

Discussion

The aim of the study was to form a consensus-based agreement on a definition of a process variable within an MSK care pathway. The NGT method was used instead of other methods because the NGT allowed for a collaborative environment between study participants with open and interactive debate and discussion [38]. The vNGT is not a time-demanding method, and it allows expert participants with opinions on process variables to come together virtually and discuss differing viewpoints before exploring mutual solutions in real time [43, 44]. The NGT method facilitated an exploratory inquiry into this previously undefined area of health care and led to a clear consensus being formed via the ranking process [39]. The final definition identifies that a process variable is any single modifiable factor in a health process or MSK care pathway that can influence patient or operational outcomes.

The participants provided examples of process variables in MSK care pathways during stage two of the vNGT. There was agreement between participants with common examples of process variables, including timeliness and access to care, referral criteria and the measurement of patient outcome measures. The examples of process variables provided by the participants appeared to reflect the participant's background. The clinically

orientated participants focused on the operational flow of patients through an MSK care pathway including the entry and exit criteria, clinical roles, and responsibilities and the timing of assessment/treatment. It is believed that the patient's flow and seamless navigation of a care pathway can influence downstream outcomes [20–22]. The non-clinical participants gave examples of process variables that were related more to the design and implementation of the MSK care pathway, including information technology integration, pricing models, coordination of care, key performance indicators and the digital enablement of patients/clinicians. It is thought that the processes of care that rehabilitation patients experience can be enhanced with the integration of digital technologies and artificial intelligence applications by healthcare organisations [45, 46].

The group discussion stage of the vNGT gave the participants the opportunity to hear alternate viewpoints, pursue areas of agreement and seek further explanation from each other [38]. At the start of the group discussion, most participants agreed that process variables can be measured or quantified and that they influence patient outcomes. Collaborative discussion occurred, and it was agreed among the group that there are interdependent factors or components of an MSK care pathway, such as information technology processes, environmental/funding contexts, and clinician training, that influence a patient's recovery that are not process variables. This is consistent with the current literature, which suggests that process variables are different from the structural factors of a health care system, such as physical facilities and organisational management systems [47]. The participants agreed that process variables are also distinct from quality indicators that are used measure health care processes, organisational structures, and outcome measures [48, 49]. The group was unanimous that process variables can influence patient outcomes regardless of where the patient is in the care pathway. This finding supports previous research in which others have stated that process variables can influence patient outcomes whether or not they precede or follow treatment input [26, 27].

An area of robust discussion focused on the question of whether process variables are patient centric. Group opinion was divided in this regard, with some participants suggesting that process variables are always patient-centric, as they will continuously drive the care for a patient, be it positive or negative. The participants with this opinion considered that the effect of process variables on individual patient choice and preference needs to be considered, as this forms the basis for patient-centered care within MSK care pathways [47, 50]. Conversely, other participants stated that process variables are not patient-centric and that sometimes process variables are driven by the insurer or business model of the MSK care pathway that the patient is in. This supports the ideas of Donabedian, who believes that within health care systems, structure (including funding models) influences process, which in turn influences outcome [51–53].

There was general agreement between the participants that a process variable is a single modifiable factor within a care pathway, and it is not the collective processes of care of a given care pathway. This is compatible with the ideas of Lleras et al., who suggest that each process variable regulates the path of care toward one's recovery [54] and that paths are not linear [55]. There was a clear view among the non-clinical participants that individual process variables could improve healthcare delivery, leading to efficiencies in health systems and enhancing a patient's recovery.

The use of business or industrial processes to improve the quality and delivery of patient healthcare has received interest from researchers [23, 49, 56–58]. Healthcare organisations often use a 'whole system' quality improvement (QI) approach to improve the processes of care, streamline flow and improve costs [48, 56]. Although a QI process can bring about opportunities for system-wide efficiency and productivity, it can be a labour intensive, time consuming and costly process for healthcare organisations [23]. The confidence that participants in the current study have in the importance of individual process variables on patient outcomes provides support for health researchers and clinicians to examine the effect of single modifiable factors on health outcomes, most likely a less daunting task than having to consider the 'whole system'. The consensus-based definition of a process variable determined by this study will provide a better 'start-point' for such research.

Despite the diverse backgrounds of the study participants, there was a synergistic and collaborative approach to addressing the research question during the vNGT. The work completed by participants prior to the vNGT helped give the participants context and to 'sensitise' them to the need for a definition [40, 59]. It also helped to prepare them to generate a range of ideas and to facilitate the sharing of those ideas in the group discussion stages of the v-NGT [38]. The participant's feedback at the conclusion of the vNGT session highlighted that they had an overwhelming positive experience. The features of the Microsoft Teams platform, such as screen sharing and chat functions, were appreciated by the participants, as was the use of the Qualtrics voting system.

The moderator adopted a structured vNGT approach and facilitated an environment that promoted equal participation and open communication, so all participants had their voices heard and their perspectives valued [40]. The participant's quality of their NGT experiences and the knowledge they impart is considered more important than quantity when ensuring data validity in an NGT [38, 44, 60].

The growing burden of MSK conditions and disorders worldwide continues unabated and change needs to occur [3, 4, 7]. To the best of our knowledge, the current study is the first attempt to define an expert, consensus-based definition of a process variable within an MSK care pathway or indeed a health care system. The NGT participants unanimously agreed upon the definition of a health process variable that recognises that it must be modifiable, quantifiable and be able to influence a patient's outcome. This is a robust consensus agreement, and the authors believe that if future researchers or health system designers adopt this contemporary definition, it will help standardize the way in which process variables are identified and examined.

Future research should focus on gaining a better understanding of the association between process variables and their influence on patient and operational outcomes of MSK care pathways. Specifically, researchers should examine whether a single process variable or any specific combination of process variables in an MSK care pathway or other healthcare system can influence outcomes [28].

Understanding patient experiences and determining what process variables matter to patients in their musculoskeletal rehabilitation journey will provide valuable insights into the barriers and facilitators to a patient's recovery [36, 61].

Increasing our comprehension of process variables may also inform future decisions about the design and implementation of health care pathways for patients with MSK conditions, including the integration of artificial intelligence and digital technology [45, 46].

Having a definition of a process variable may also allow researchers to develop a conceptual framework for examining process variables, and this may assist in the global effort to reduce the burden of disability and cost currently associated with MSK conditions [1, 3, 25, 30].

Limitations

Although this study has provided a consensus-based definition of a process variable, there are some limitations of the study. Although the recommended number of NGT participants was satisfied and there was a good balance of males to females and between clinician and non-clinicians, the participants with clinical backgrounds were solely MSK physiotherapists. Additionally, most participants only had experience in the New Zealand health system, perhaps limiting the generalisability of our definition of a process variable to other jurisdictions.

The use of the virtual platform instead of a traditional face-to-face NGT may have influenced the interaction between participants in the group discussion phase given that non-face-to-face communication such as body language could not be readily observed and that some participants may have felt less confident in speaking in this environment. We attempted to mitigate this by effective moderation to facilitate equal opportunity to participate and contribute. We could have used another method, such as Delphi, but we feel the vNGT was an effective method to deliberate and reach a timely consensus on a unique aspect of health care that had limited time or cost constraints on both the participants and the researchers. The vNGT adheres to the foundational principles established for consensus methods, including structured interaction, iteration, controlled feedback, and anonymous voting [38, 44, 62].

Conclusion

Our study of experts has formed a consensus-based agreement for a definition of a process variable in a MSK care pathway within the New Zealand setting. This is an important first step in developing our understanding of process variables, and further research is needed to establish the link between process variables and their influence on the outcomes of patients with MSK conditions.

Abbreviations

MSK	musculoskeletal
YLD	years lived with disability
TKA	Total knee arthroplasty
ACC	Accident Compensation Corporation
ECP	Escalated Care Pathway
AUTEC	Auckland University of Technology Ethics Committee
vNGT	virtual nominal group technique

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Informed consent statement

All participants in the vNGT study gave signed informed consent to participate.

Availability of data and materials

We don't have any research data outside the submitted manuscript file..

Authors' contributions

DH, SW, DR and CC contributed to the conception and design of the study. DH carried out the nominal group technique. DH drafted the manuscript and SW revised it. DH, SW, DR and CC read and approved the final manuscript.

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Daniel Harvey is a Board Registered Specialist Musculoskeletal Physiotherapist in New Zealand. He owns and works at Sports& Spinal Physiotherapy. He is a PhD candidate at AUT University, investigating the effects of process variables on musculoskeletal patient outcomes.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The Auckland University of Technology Ethics Committee (AUTEC) approved this study (AUTEC 23/94) and in accordance with the Declaration of Helsinki.

Consent for publication
Written informed consent for publication was obtained from all participants.
Availability of data and materials.

Competing interests
The authors declare no competing interests.

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