Clinical Caremap Development: How Can Caremaps Standardise Care When They Are Not Standardised?

Scott McLachlan[1,2], Evangelia Kyrimi[2], Kudakwashe Dube[1,3] and Norman Fenton[2]
[1]*Health Informatics and Knowledge Engineering Research Group (HiKER), New Zealand*
[2]*Risk and Information Management, Queen Mary University of London, London, U.K.*
[3]*School of Fundamental Sciences, Massey University, Palmerston North, New Zealand*

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Abstract: Caremaps were developed to standardise care. They have evolved from text-based descriptions to flow-based diagrams. Standardising care is seen to improve patient safety and outcomes, and to reduce the costs of providing healthcare services, but contemporary caremaps are not standardised. This research investigates contemporary caremaps and proposes a standardised model for caremap content, structure and development. The proposed model is evaluated through two case studies to create caremaps for; 1) obstetric care during labour and birth, and; 2) management and for women with gestational diabetes mellitus, finding that it is an effective method for creating standardise caremaps.

1 INTRODUCTION

Caremap is a term currently used to describe a graphical representation of the sequence of patient care activities to be performed for a specific medical condition. Caremaps have existed in some form for around forty years (Hampton, 1993; Zander, 2002; Gemmel et al., 2008). The literature suggests they originated in the nursing domain, incorporating and extending the critical pathway method and bringing established project management methodologies into healthcare delivery (Chu and Cesnik, 1998); (Gemmel et al., 2008); (Zander, 1992). Caremaps are intended to standardise health services by organising and sequencing care delivery, ensuring a standard of care and timely outcomes using an appropriate level of resources (Marr and Reid, 1992; Hampton, 1993; Blegen et al., 1995; Bumgarner and Evans, 1999). The caremap can also help track variance in clinical practice, as it provides a simple and effective visual method for identifying when treatment or patient outcomes have deviated from the routine evidence-based pathway (Marr and Reid, 1992), (Houltram and Scanlan, 2004).

Terminological disagreement persists as to whether caremaps are a separate format of clinical tool (Zander, 1992; Kehlet, 2011; Solsky et al., 2016), or simply another name for care pathways, clinical pathways, critical pathways and care plans (Holocek and Sellards, 1997; Campbell et al., 1998; O'Neill and Dluhy, 2000; Li et al., 2014). This terminology confusion is further exemplified when we observe flow diagrams that internally describe themselves as a "care map", yet are captioned 'clinical pathway' by the author such as observed in Figure 1 of (Thompson et al., 2011) and Figure 5 on p45 of (Yazbeck, 2014). Yazbeck (2014) goes on to present a range of similar flow diagrams for care management, describing them using a range of titles including 'care map', 'care pathway', and 'algorithm'.

Nursing caremaps from the early 1990's contained considerably more text than their contemporary counterparts, and were presented as the sum of two components: (1) identifying patient problems and necessary outcomes within a time-frame which are (2) broken down and described day-by-day as tasks on a critical path, (Marr and Reid, 1992; Ogilvie-Harris et al., 1993). Later approaches presented three components: (1) the flow chart diagram; (2) the transitional text-based care map of activities broken down day-to-day, and; (3) the evidence base relied upon in their construction (Houltram and Scanlan, 2004). It is these approaches which may have resulted in the terminology confusion that persists to today.

More recent caremaps have tended towards representation as a flow diagram made up of clinical

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options for a particular condition and resulting in multiple possible paths based on: (i) symptomatology; (ii) diagnostic results, and; (iii) how the patient responds to treatment (Chan et al., 2005; BCCancer, 2012; deForest and Thompson, 2012). Caremap examples can be found in many healthcare domains, including: paediatric surgery (Chan et al., 2005), nursing (deForest and Thompson, 2012), oncology (BCCancer, 2012), diagnostic imaging (WAHealth, 2013), obstetrics (Comreid, 1996) and cardiology (Hampton, 1993). Even within these examples there exists significant variance in complexity level, design approach, content and the representational structures used. There is currently no standardised method for the development or presentation of a clinical caremap (Bumgarner and Evans, 1999). Changes in format between like documents and poorly designed materials increase ambiguity and create confusion for the clinician (Hubner et al., 2010), (Valenstein, 2008), (Wang et al., 2013). Standardised approaches to documentation ensure that each time a clinician approaches that type of document, the content and format meet their expectations, can be read quicker, are better retained, and improves patient safety and outcomes (Christian et al., 2006; Valenstein, 2008). For this reason our paper asks: how can caremaps be an effective tool to standardise healthcare when caremaps themselves are not standardised?

The rest of this paper is organised as follows: Section 2 discusses caremap terminology, history and evolution. Section 3 defines the problem of standardisation and Section 4 reviews related literature. Section 5 presents the methodology and results of a literature review on the primary elements of caremaps. The proposed standardised caremap model is described in Sections 6 and 7 and validated in Section 8 through the conduct of two case studies in the area of midwifery and obstetrics. The paper is then summarised and concludes with proposals for future work.

2 CAREMAPS: *TERMS, BACKGROUND AND CONTEXT*

2.1 Caremap Terminology

Definitions drawn from literature of the early-mid 1990's agree in principle that the caremap presents as a graph or schedule of care activities described on a timeline and performed as part of the patient's treatment by a multidisciplinary team to produce identified outcomes (Marr and Reid, 1992; Hampton, 1993; Ogilvie-Harris et al., 1993; Blegen et al., 1995; Wilson, 1995; Gordon, 1996; Hill, 1998; Zander, 2002). While the format of caremaps has changed over the intervening decades, this general definition is still appropriate.

Caremaps are observed under three different titles: caremaps, CareMaps and care maps. The first appears to have been the original title prior to the Centre for Case Management (CCM) trademarking CareMaps in the early 1990's (Blegen et al., 1995; Dickinson et al., 2000). In literature published after 1994 that uses caremaps, it is not uncommon to see some mention of CCM or their trademark (Philie, 2001), although some don't (Griffith et al., 1996; Saint-Jacques et al., 2005). The use of care maps has possibly come as a defence to any potential issues that might have arisen from confusion with the trademark, as we did not see authors using this third type in context or with reference to CCM (Marr and Reid, 1992; Mackay et al., 2007; Royall et al., 2014).

2.2 Background of Caremaps

While there appear to be three descriptions for the origin of caremaps, there are points of intersection between each. The descriptions are:

(1) That caremaps resulted as an output of the CCM in 1991 (Dickinson et al., 2000). CCM's CareMaps were similar in form and function to existing clinical pathways and were applied to specific patient populations that were commonly treated in high numbers in hospitals (Dickinson et al., 2000). This organisation then went on to trademark the double-capitalised version CareMap but had not within the first decade undertaken any research to demonstrate effectiveness of the concept whose invention they claimed (Jones and Norman, 1998).

(2) That caremaps naturally evolved as an expansion of earlier case management and care plans (Zander, 2002).

(3) That caremaps were developed during the 1980's at the New England Medical Centre (NEMC) (Wilson, 1995; Schwoebel, 1998).

There is some support for the notion that caremaps had existed in the decade before the CCM's 'invention' and trademark, in that it had been observed that nurses were the primary users of caremaps in the 1989 (Etheredge, 1989; Wilson, 1995).

Where the intersection occurs is: (a) between the first two descriptions and in the way that staff of

CCM have sought to elevate differences between clinical pathways and their model of CareMaps; identifying that the former represented a first-generation concept while the latter improves on it by adding consideration of variance and outcome measurement (Morreale, 1997), and; (b) between the last two in that each has some element in their story suggesting caremaps came into existence in the 1980's.

2.3 Caremap Evolution and Current Context

Early caremaps were text-based and holistic. Rather than focusing on just the immediate primary diagnosis or intervention, nurses developed them to focus on the entire scope of care that might be necessary for the patient during their hospitalisation event. These traditional caremaps considered elements such as anxiety, rehabilitation, education, prevention and coping strategies and were intended to restore the patient to a normal quality of life (Marr and Reid, 1992; Goode and Blegen, 1993; Ogilvie-Harris et al., 1993; Wilson, 1995; Feigin, 1996).

In the second half of the 1990's care providers began to identify that creating caremaps was easier for surgical procedures than other in-hospital care intervention situations (DeJesse et al., 1995). Evolution of caremaps in form and function was expected as information technology and evidence-based medicine developed (Wilson, 1995). Starting from 1999 there began to be examples of transitional caremaps; caremaps that whilst still being text-based, have reduced their focus to interventions limited to the primary diagnosis (Bumgarner and Evans, 1999; Cholock, 2001; Philie, 2001).

As caremaps evolved into graphical representations we begin to find contemporary caremaps presented as a separate but complementary component to the clinical pathway or clinical practice guideline (Dickinson et al., 2000); (Saint-Jacques et al., 2005). More recent caremaps are linked to or provide a graphical flow representation for a clinical practice guideline (CPG) or surgical event (Houltram and Scanlan, 2004; Chan et al., 2005; Royall et al., 2014). While retaining the purpose and flow, many of those seen today annexed to CPGs have even dropped the title (RWH, 2010; TCHaW, 2010; Thompson et al., 2013; Reading et al., 2015). A summary of the relevant elements of each caremap type is included in Table 1.

3 THE PROBLEM: *STANDARDISING THE CAREMAP AND ITS DEVELOPMENT PROCESS*

Proponents see standardisation of care processes as an effective method for reducing healthcare service delivery costs and variation, while increasing quality, safety, efficacy and outcomes, improving the patient experience and overall quality of life (Appleby et al., 2011; Zarzuela et al., 2015). Yet we see that healthcare remains one of the slowest industries to adopt process standardisation or to demonstrate it has positive impacts on patient safety and outcomes (Leotsakos et al., 2014; Zarzuela et al., 2015; Binks, 2017). This in part is due to clinician resistance; with attempts at care standardisation derided as 'cookbook' or 'cookie cutter medicine' that some say

Table 1: Summary and Comparison of Caremap Evolution Stages.

	Traditional (1980's to mid-1990's) *	**Transitional** (Mid-1990's to mid 2000's) *	**Contemporary** (2004 onwards) *
Primary Author	Nurses	Nurses and Doctors	Doctors
Context	Holistic	Primary condition	Single diagnostic, screening and/or intervention event.
Foci	Restoring the patient to normal life	Outcomes, cost and resource consumption	Efficiency of care delivery and outcomes, reduction of practice variation, bridge gap between evidence and practice
Presentation	Text-based	Text-based with some early flow examples	Flow diagram or graph
Status	Independent document	Independent or sometimes incorporated with CP document	Self-contained but often found appended to/contained in CPG

CP = Clinical Pathway, CPG = Clinical Practice Guide
*All dates are approximate ranges

can only be effective after they have set aside the unique needs of individual patients (Giffin and Giffin, 1994; Rotter et al., 2008; Zarzuela et al., 2015; Corbett, 2016). Given the current overuse issues and financial crisis pervading healthcare service delivery globally, standardisation of key documentation can help clinicians deliver managed care, which is seen to reduce incidences of inappropriate and ineffective care, resource consumption and overall cost (Keyhani et al., 2014; Martin, 2014).

Caremaps, clinical and critical pathways, clinical flow diagrams and nursing care plans are observed with vastly different content and appearance within the same journal, from hospital to hospital, and sometimes even from ward to ward in the same hospital. While much literature presents caremaps and other clinical documents such as clinical pathways, and texts exist for the development of traditional text-based caremaps, a gap exists with regards to presenting a standard for the development and structure of contemporary caremaps. This research seeks to differentiate contemporary caremaps from other forms of clinical documentation, and to present one possible solution to standardising their development, structure and content.

4 RELATED WORKS

There were numerous examples of contemporary caremaps in the literature and annexed to hospital-based clinical practice guidelines (CPGs). Contemporary caremap literature tended to focus on establishing the clinical condition that justified creation of the caremap, such as: determination of incidence, risk factors and patient outcomes (Chan et al., 2005); diagnosis and stabilisation of patients with an acute presentation (deForest and Thompson, 2012), and; protocolising of ongoing treatment (Royall et al., 2014). Presentation or discussion of the development process and elements for construction were rare, and more often had to be inferred via a thorough reading of each paper.

A single article was located that attempts to describe a systematic process for contemporary caremap development (Sackman and Citrin, 2014). Authored by a veterinarian and a lawyer, this article focuses more on standardising care process representation into a clinical caremap for the purposes of cost containment and provides the example of mapping a surgical procedure (Sackman and Citrin, 2014). Given their focus and particular caremap construction which, through their own exemplar application only includes a temporally-ordered single-path representation of the gross steps of patient care, their paper might only be considered formative at best. By their own admission they deliberately limited the relevant data analysed during the input design phase to only what is truly critical for identifying and understanding outliers, which results in its lack of clinical applicability and distinct lack of detail surrounding each care process (Sackman and Citrin, 2014). Their method requires significant work to adequately support true standardised clinical caremap development.

5 METHODOLOGY

Literature Review: A search using the terms ‘caremap’, ‘CareMap’, and ‘care map’ was conducted across a range of databases. A citation search was also performed on all included papers. This search yielded 1,747 papers. Once duplicates, papers not based in the nursing, medical or healthcare domains and those using the term “care map” in other contexts were removed a core pool of 115 papers remained.

Development of Review Framework using Thematic Analysis: Initially each paper was reviewed using standard content and thematic analysis (Vaismoradi et al., 2013) and concept analysis (Stumme, 2009) to identify and classify terminology, construction and content elements and infer development processes.

Methodology for Standardisation of Caremaps: Literature reviews have a ground-level consensus forming function allowing identification of implementation techniques and the degree of accord within a domain (Bero et al., 1998; Cook et al., 2013). The literature pool was used to identify common definition, structure and content elements of caremaps. In addition, process steps that were consistently described led us to a standardised caremap development process.

Methodology for Evaluation of Proposed Standard for Caremaps: Case Studies are a grounded comparative research methodology with a well-developed history, robust qualitative procedures and process validation (McLachlan, 2017). The case study approach provides a real-life perspective on observed interactions and is regularly used in information sciences (Lee, 1989; Cable, 1994; Smithson, 1994; Peak et al., 2005). Case studies are considered as developed and tested as any other scientific method and are a valid method where more rigid approaches to experimental research cannot or do not apply (Eisenhardt, 1989; Tellis, 1997; Yin,

2011). Both the standardised development process and resulting caremap are evaluated using case studies of examples from the author's other works.

6 CONSENSUS FORMATION ON CAREMAP: *COMPOSITION AND DEVELOPMENT PROCESS*

The literature was used to establish consensus on common structure, content and development processes previously used in the creation of caremaps, and which may be relevant in defining standard caremap and development processes. The case studies are used to evaluate and refine each. The research was conducted following the overall approach presented in Figure 1.

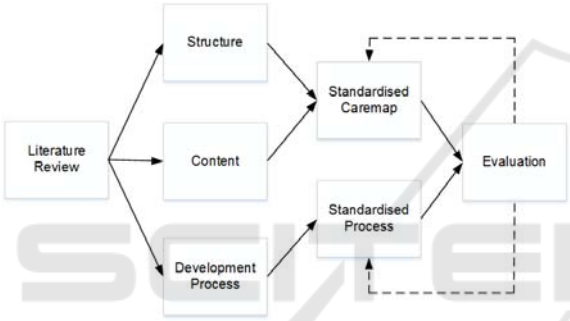

Figure 1: Research process – Consensus formation and evaluation.

To address the stated aim of this paper, we focused our research on tertiary care (hospital-borne) caremaps and specifically the following three components whose characteristics came out of the thematic analysis and make up the review framework:

Structure	What is the representational structure and notation for expressing contemporary caremaps?
Content	What content types are consistently seen in contemporary caremaps?
Development	What are the process steps followed for developing contemporary caremaps?

6.1 Structure

As described in Table 1, caremaps have evolved from wordy texts (Goode and Blegen, 1993; Gordon, 1996; Holocek and Sellards, 1997; Bumgarner and Evans, 1999; Matula and Shollenberger, 1999; Philie, 2001) to illustrative graphs (Chu and Cesnik, 1998; Panzarasa et al., 2002; Houltram and Scanlan, 2004; Li et al., 2014; Royall et al., 2014; Michelson et al., 2018). Most contemporary caremaps present either as monochromatic, i.e. black and white (Dickinson et al., 2000; Chan et al., 2005; Ye et al., 2009; Gopalakrishna et al., 2016) or full colour (Saint-Jacques et al., 2005; Milne et al., 2013) flow diagrams: a well-known process modelling tool (Gilbreth and Gilbreth, 1921). Generally, each flow diagram has its own boxes and notations, and the most common is a rectangle that represents a process step, usually called an activity. Contemporary caremaps contain a set of activities representing medical care processes. However, the literature shows there is no consistency in the way that an activity is represented. Different shapes such as rectangular boxes with rounded (Thompson et al., 2011) or square corners (Chu and Cesnik, 1998; Panzarasa et al., 2002; Royall et al., 2014), plain text (Dickinson et al., 2000), or even arrows (Gopalakrishna et al., 2016) have been used. In some cases, activities that lead to different mutually exclusive pathways are presented by a diamond (Panzarasa et al., 2002; Ye et al., 2009; van de Klundert et al., 2010; Li et al., 2014). The flow from one activity to another is illustrated with arrows (Panzarasa et al., 2002; Houltram and Scanlan, 2004; Chan et al., 2005; Milne et al., 2013), or simple lines (Dickinson et al., 2000; Li et al., 2014). The literature lacks a clear description as to whether a caremap should have an entry and an exit point. In some cases neither is present (Houltram and Scanlan, 2004; Thompson et al., 2011; Royall et al., 2014), while in others these points are an implicit (van de Klundert et al., 2010; Li et al., 2014; Michelson et al., 2018) or explicit part of the diagram (Panzarasa et al., 2002). Finally, most of the reviewed caremaps contain multiple pathways and they are often presented as multi-level flow charts (Chu and Cesnik, 1998; Panzarasa et al., 2002; Ye et al., 2009).

6.2 Content

Each activity in the caremap represents a specific medical process. Diagnosis, treatment and ongoing monitoring/evaluation are three medical activities that are consistently observed (van de Klundert et al., 2010; Thompson et al., 2011; Huang et al., 2012). It is common for a caremap to contain a set of targeted outcomes (Chu and Cesnik, 1998; Panzarasa et al., 2002; Chan et al., 2005; Li et al., 2014; Royall et al., 2014). Time, described either as a duration or inferred from the step-by-step nature of the dynamic care process, is often part of the caremap (Saint-Jacques et al., 2005; Ye et al., 2009; van de Klundert et al., 2010; Michelson et al., 2018). Finally, an explanation

associated with the activities and/or arrows captured in the caremap may be present (Houltram and Scanlan, 2004; Chan et al., 2005; Saint-Jacques et al., 2005), (Ye et al., 2009; Thompson et al., 2011; Milne et al., 2013; Royall et al., 2014; Michelson et al., 2018). The explanation helps to better describe an activity or to justify the flow from one activity to another.

6.3 Development Process

The development process of a contemporary caremap is a subject that has gained significantly less attention in the literature. Only 19 out of the 115 papers provides any detail regarding the development process. Of these only 6 describe the development process with any deliberate nature or clarity (Giffin and Giffin, 1994; Hydo, 1995; Thompson et al., 2011; Huang et al., 2012; Lodewijckx et al, 2012). From the rest, the steps to develop the caremap can only be inferred (Hill, 1998; Dickinson et al., 2000; Panzarasa et al., 2002; Royall et al., 2014).

7 TOWARDS STANDARDISATION OF CAREMAPS

7.1 Model for Standardised Caremap Structure

Contemporary caremaps are presented as flow diagrams. However, as described in Section 6.1 there is neither a consistent caremap structure nor a good representation of the elements included in a caremap. To resolve this problem an entity relationship model, shown in Figure 2 that describes the relationship among structural elements of a caremap, demonstrated in Table 2, is proposed. The elements are inspired by the standardised pictorial elements seen in UML and hard state chart notations. Following this, the standardised structural model of the caremap is demonstrated in the content model shown in Figure 3.

7.2 Model for Standardised Caremap Content

The three main content types that were consistently captured in the contemporary caremaps were diagnosis, treatment and management/monitoring. These are broad content types related to a set of specific medical activities and data captured as shown in Table 3. Following the structural model, an exemplar content model is presented in Figure 3. The three main content types represent different caremap levels, while the described medical activities are the components of that type of caremap. The proposed standard content model represents the information that should be captured in a caremap.

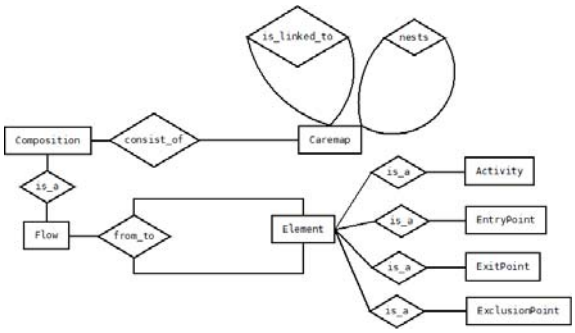

Figure 2: An Entity Relationship model for the caremap.

Table 2: Structural elements of caremaps and their representational notation.

	Element	Description	Notation
1	*Entry point*	Beginning of the caremap	
2	*Exit point*	End of the caremap	
3	*Exclusion point*	Exclusion from the caremap, as the patient does not belong to the targeted population	
4	*Activity*	A care or medical intervention that is associated with a medical content type *(see Table X in next section)*	
5	*Nested Activity*	An activity that has an underlying caremap	
6	*Flow*	Transition from one activity to another	
7	*Multiple pathways*	Flow from an antecedent activity to a number of successors from which the clinician must choose the most appropriate ongoing path	
8	*Nested caremap connection*	Connection between an activity and its nested caremap	
9	*Multi-level caremap connection*	Connection between a series of linked caremaps	

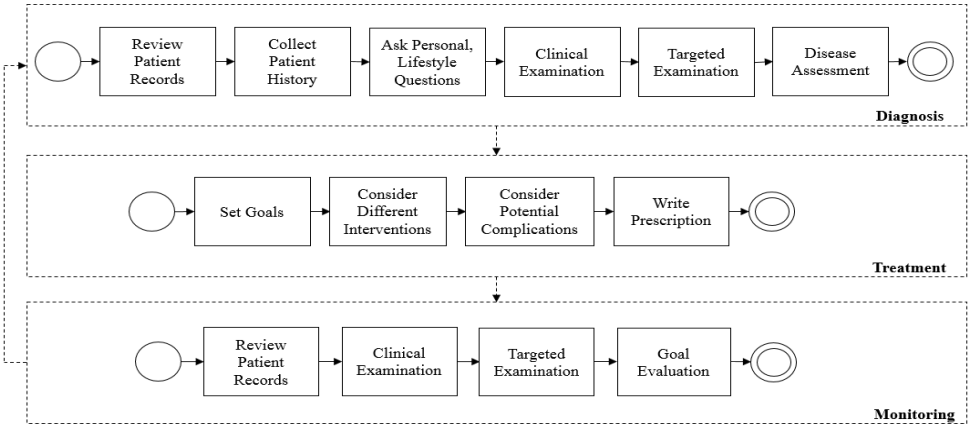

Figure 3: Content model for the caremap.

Table 3: Content type, activities and information captured in caremap.

Content Type	Activity	Data/Information Captured
Diagnosis	Review patient records	Demographics Medical history
	Collect patient history	Family history Comorbidities
	Ask personal, lifestyle questions	Habits (risk factors)
	Clinical examination	Signs Symptoms
	Targeted exam	Diagnostic test results
	Disease assessment	Diagnosis
Treatment	Set goals	Expected Outcomes
	Consider different interventions	Possible treatments
	Consider potential complications	Variances from expected outcomes
	Write prescription	Selected treatment Treatment details
Monitoring	Review patient records	Previous test results Previous symptoms
	Clinical exam	Signs/Symptoms
	Targeted exam	Diagnostic test results
	Evaluate goals	Progression

7.3 Model for Standardised Caremap Development Process

Figure 4 presents the proposed development process divided into six phases. During the initial phase the conceptual framework should be decided, and a multidisciplinary team assembled. The next phase clarifies current practice and anticipated variance. A review of available evidence is the final step prior to production of the caremap. Once developed, it should be evaluated and once agreed, implemented. As Figure 4 shows, caremap development is a lifecycle process. As new knowledge for the particular condition or treatment or variance is identified, the caremap should be reviewed (Huang et al., 2012).

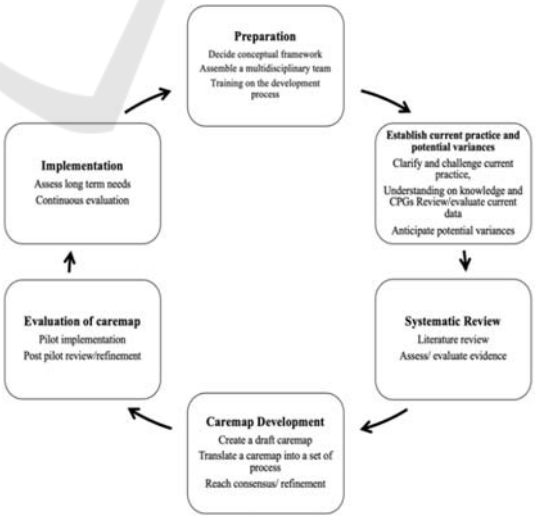

Figure 4: Caremap development lifecycle.

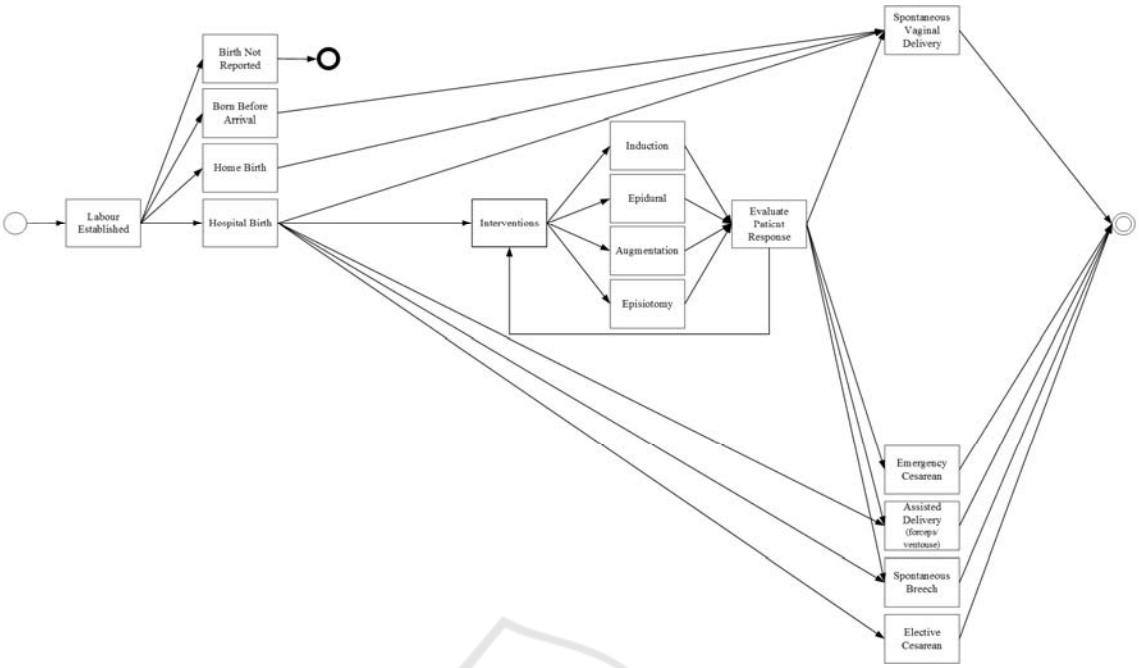

Figure 5: Labour and Birth Caremap.

8 EVALUATING THE STANDARD

8.1 Study I: The Labour and Birth Caremap

The labour and birth process represents an excellent example for a first-pass evaluation case study to assess the development process for caremaps. Labour and birth has easily defined start and end points, limited temporal variance, and a finite number of easily identified treatment paths.

Inputs: Inputs for the labour and birth caremap were: (a) clinical practice guidelines for intrapartum care at Middlemore Hospital; (b) input and consensus of midwives and obstetricians, and; (c) publicly available incidence and treatment statistics from the NZ Ministry of Health.

Development: An iterative development process was used wherein the information scientist created an initial version of the caremap based on the clinical practice guideline (CPG) and evidence derived from the treatment statistics. The initial caremap was revised and refined during a number of sessions with the clinicians. The resulting labour and birth caremap for Middlemore Hospital is shown in Figure 5.

Validation: The Ministry of Health annually publish Maternity and Newborn Data and Statistics for each birthing unit and hospital. These statistics are presented in the form of a contingency table whereby the possible birthing outcomes and clinical interventions are interrelated with a whole range of demographic and clinical variables (maternal age at birth, ethnicity, deprivation, maternal BMI and so on). Using the 2014 release of these statistics, we calculated the most likely treatment path that would have been undertaken for all 8,731 birthing mothers at one hospital unit. A state transition machine was developed, digitised and realistic synthetic electronic health records (RS-EHR) for all 8,731 women were synthetically generated (McLachlan *et al*, 2016). The treatment paths for each woman were digitally compared against the caremap in Figure 5 to ensure a valid path solution resolved for every recorded birth. In this way we demonstrated that the caremap represents the entire scope of patient presentations and treatment options as performed by clinicians.

8.2 Study II: The Gestational Diabetes Mellitus Management Caremap

As part of a project to design and build a population-to-patient predictive learning health system (LHS) to reduce clinical overuse and empower patients to actively participate in their own care, Queen Mary

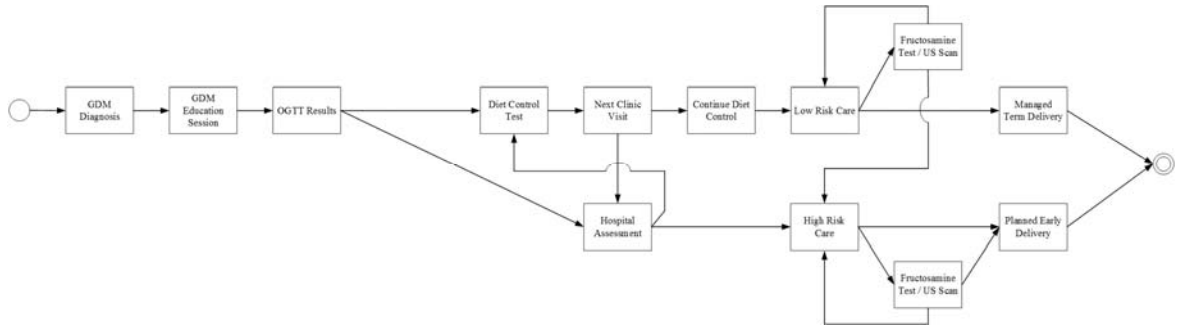

Figure 6: Gestational Diabetes Mellitus Management.

University of London's PAMBAYESIAN project (www.pambayesian.org) is creating a Bayesian Network (BN) model (Fenton and Neil, 2018) to predict treatment needs for individual mothers with gestational diabetes mellitus (GDM). The process initially required creation of three caremaps, for (1) diagnosis; (2) management, and; (3) postnatal follow up.

***Inputs**:* Inputs for the labour and birth caremap were: (a) clinical practice guidelines for care of women with diabetes in pregnancy, and; (b) input and consensus from midwives and diabetologists.

Development: An iterative development process was used wherein the decision scientist and midwifery fellow worked together to deliver an initial version of the caremap based on the clinical practice guidelines (CPG) and clinical experience. The initial caremap was revised and refined during a number of sessions with the clinicians. Figure 6 presents the resulting clinical management caremap for GDM.

Validation: Validation was performed through consultation seeking consensus from three diabetologists with tertiary care experience treating obstetric patients under the CPGs used in the caremaps' creation.

9 SUMMARY AND CONCLUSIONS

Some see standardising of care as limiting their ability to make decisions based on the patient presenting before them, creating 'cookie-cutter medicine'. However, caremaps are a form of standardised clinical documentation that improve patient safety and outcomes while still allowing clinicians to select the most appropriate path for their patient. Caremaps evolved during the last three decades from primarily text-based approaches developed by nurses, to flow-based visual aids prepared by doctors as representations of clinical screening, diagnosis and treatment processes. These contemporary caremaps are presented in a variety of ways and with differing levels of content. Contemporary caremaps lack standardisation.

This paper presents one solution for standardising caremap structure and content, and an approach for caremap development distilled directly from analysis of the entire pool of literature. The development process was evaluated and refined during the development of caremaps for case studies in obstetrics and midwifery: (a) labour and birth, and (b) management of patients with GDM. The resulting caremaps were validated by expert consensus, with the labour and birth caremap also being developed as a state transition machine enabling rapid digital validation against a dataset of synthetic patients.

If used consistently, the methods presented in this paper will bring standardisation to caremaps and ensure that, as clinical staff move between busy units in a tertiary care setting, they are not distracted from the patient in effort to understand the care flow model. Every caremap would be familiar and time can be given over to treating their patient, not trying to understand the document.

Future work should address a standard approach for identifying and representing the decision points within a caremap, digital imputation of the caremap, and representation of caremap logic in other computer-aware and algorithmic forms, including Bayesian Networks or Influence Diagrams (Fenton and Neil 2018). These can form part of a learning health system and provide population-to-patient level prediction.

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