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Value-based healthcare from a military health system perspective: a systematic review

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ABSTRACT

Objectives The aim of this systematic review was to provide an overview of value-based healthcare (VBHC) strategies and/or components within military medicine. For this purpose, the extent to which VBHC has been applied within a military health system (MHS), with emphasis on military trauma care was assessed.

Design This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

Data sources Medline, Embase, Web of Science CC and the Cochrane CRCT databases were searched from 1946 to present for VBHC strategies and/or components and military settings, including associated keywords.

Eligibility criteria for selecting studies We included observational and trial studies focused on the presence of VBHC components and/or system, and the presence of acute/trauma operational care or definitive postoperational care regarding combat injured service members. The included articles were classified into injury-related and system-level studies.

Data extraction and synthesis Two independent reviewers used standardised methods to search, screen and code included studies. For quality assessment, the Mixed Methods Appraisal Tool version 2018 was used.

Results A total of 3241 publications were screened, and 18 were included for data extraction. 15 studies focused on (military) medical trauma-related conditions (injury groups), and 3 studies focused on an MHS approach. Four articles contained the two VBHC components ('creating an integrated practice unit' and 'measuring outcomes and costs for every patient') considered the basis for successful implementation. The 'outcomes and costs' and 'patient-centred care' components were most prevalent as respectively mentioned in 17 and 8 included studies.

Conclusion The systematic review showed the application of VBHC components in military medicine, although use of standard VBHC terminology is not consistently applied. This study suggests that implementing VBHC as a concept in military healthcare, could enhance benchmarking to provide insight in health outcomes (both clinically and patient-reported), and overall quality of care.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ To our knowledge, this systematic review is the first to review value-based healthcare (VBHC) strategies and/or components in military medicine and military health system (MHS).
⇒ As this is the first systematic review around this topic, we decided to use a robust search strategy of (components of) VBHC applied in the whole of military healthcare and veteran healthcare.
⇒ Research has identified areas where VBHC strategies and components have been applied in military healthcare, which, when combined with civilian developments in medicine, contribute to standardisation and objective measures for use in clinical practice and during future research.
⇒ This study delivered no tangible evidence on the likelihood for success of implementing VBHC in MHS.
⇒ The limited application of VBHC (components), including the very poor use of VBHC terminology made it difficult to fully answer the research question.

INTRODUCTION

In 2006, with Porter and Teisberg's introduction of the concept of value-based healthcare (VBHC), a model of delivering high-value care for patients was launched.[1] Value in healthcare is measured in outcomes achieved, not in the volume of services delivered.[2] The transformation to VBHC is already taking place on a broad scale in some countries,[3 4] with overarching change strategies being implemented. The operationalisation of the overarching strategy has been shaped by the 'Value Agenda'.[5] In the following years, the interrelated six components were further developed: 'organise care into integrated practice units', 'measure outcomes and costs for every patient', 'move to bundled payments for care cycles', 'integrate care delivery systems', 'expand geographic reach' and 'build an enabling information technology platform'.[6] An even further operationalisation of value in healthcare is to include the concepts of patient-centred care and shared decision-making.[7–9] Despite the differences between the two

concepts, as well as the existing complementarity, both can help strengthen the patient's position in his/her care pathway. Furthermore, the conceptualisation and implementation of VBHC have a high degree of diversity in interpretation, resulting in a lack of comprehensive implementation.[3 5]

When assessing military healthcare through the lens of VBHC, this lack of comprehensive implementation may be of a more complex nature due to the distinctive structure and application of military healthcare. Military healthcare is provided both as regular care at home and during operations up into the high violence spectrum and/or particularly difficult (climatic) conditions. This care will be provided by a military health system (MHS) that partly mirrors the civilian health system but can also provide care for military personnel everywhere and under all conditions. To approach the care of service members as a whole (both at home and everywhere), the MHS works with a care pathway in which care should be integrated seamlessly. This also shows the difference between MHS and civilian care.

The operational military patient care pathway represents a continuum of care designed to ensure that the service member is fit for operational duty at return to duty (after being wounded or sick).[10 11] This pathway is firmly built around the volume of services delivered, amplified by the current geopolitical developments and military threats.[12] A transformation of VBHC towards more and better measurement of outcomes and improving quality in healthcare and thereby reducing costs can add value to military medicine. Nevertheless, while a cost reduction may potentially enhance the value proposition, the primary objective is to optimise the health outcomes for the service member in conjunction with the optimal state of military readiness. Furthermore, the available literature predominantly describes military medicine and VBHC separately, with the impression that there is certainly a considerable overlap. Therefore, it is important to identify the existing relationships between military medicine and VBHC. This work can contribute to the understanding within an MHS to strive for value in addition to maintaining the required volume of services.

The aim of this systematic review is to provide an overview of the implementation of VBHC strategies and components within military trauma care (defined as operational trauma/acute care and (post-)operational definitive care, including rehabilitative care), to help determine the feasibility of VBHC in MHS. To address this, we conducted the following research questions:

1. Has (parts of) VBHC been applied in MHS and trauma care?
2. To what extent have VBHC strategies and components been applied within the operational military patient care pathway?
3. To what extent is the use of VBHC strategies and components feasible in the MHS?

METHODS

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines[13 14] and the PRISMA-S extension to the PRISMA Statement for Reporting Literature Searches in Systematic Reviews.[15] The PRISMA 2020 (abstract) checklists are presented in online supplemental material S1 and S2.[16]

Search strategy

An experienced information specialist (MFME) in cooperation with the first author (HvdW) developed an exhaustive search strategy. The search was developed in Embase.com, optimised for sensitivity and then translated to other databases following the method described by Bramer *et al*.[17] The search was carried out in the databases Medline ALL via Ovid (1946–present), Embase.com (1971–present), Web of Science Core Collection (Science Citation Index Expanded (1975–present) and the Cochrane Central Register of Controlled Trials via Wiley (1992–present). Additionally, a search was performed in Google Scholar from which the 200 highest-ranked references were downloaded using the software Publish or Perish.[18] After the original search was performed in March 2022, the search was last updated on 12 February 2024, using the methods described by Bramer *et al*.[19] In all databases, terms were searched in titles and abstracts of references and keywords added by the authors. The search contained terms for (1) VBHC and associated keywords and (2) military setting and associated keywords. Keywords searched including value-based healthcare, patient-centred care, patient-reported outcomes, trauma, multi-trauma, rehabilitation, active-duty service member, veteran, military, military medicine, military health system, operational, war-related injury and quality of life. Terms were combined with Boolean operators AND and OR, and proximity operators were used to combine terms into phrases. The full search strategies of all databases and database details are available in online supplemental material S3.[16] The references were imported into EndNote, and duplicates were removed by MFME using the method described by Bramer *et al*.[20]

Selection criteria and study selection

All identified studies were screened for title and abstract. Articles were included when both researchers HvdW and DD agreed that the inclusion criteria were met. Inclusion criteria were as follows: (1) VBHC components were implemented and (2) the studies had to be conducted in acute/trauma operational care or postoperational definitive care regarding combat injured service members. After the first screening, both researchers performed a full-text screening on the included studies to exclude any non-related or non-retrievable articles. The exclusion criteria were as follows: (1) there was no implementation of VBHC strategies, (2) there was no application of VBHC components, (3) the article did not mention acute/trauma care in military operations (operational) and (4)

the article did not mention definitive healthcare/rehabilitation (postoperational) for service members (screening matrix in online supplemental material S4).[16] After full-text screening, the articles that were not excluded were eligible for quality assessment.

Quality assessment

The Mixed Methods Appraisal Tool (MMAT)[21] was used for quality appraisal of the included studies. This tool is applicable to qualitative, quantitative and mixed methods studies. The screening consists of two parts: (1) general questions that exclude a NO or CAN'T TELL the study in question for screening in part 2. In part 2, the MMAT provides a set of five quality criteria for each study design. The scores resulted in a classification of each study into research quality from 0/5 to 5/5. The quality assessment was used to provide an overall impression of study quality. Two researchers independently conducted the quality appraisal. All eligible studies were included in the analysis regardless of their quality scores.

Data extraction and presentation

Data extraction and evaluation were carried out independently by two reviewers (HvdW, DD). Study characteristic elements were authors, year of publication, study design, country in which the study was performed, the centre or programme from which the data were derived and the phase in the military patient care pathway. The extracted data were plotted against seven (military care pathway relevant) VBHC components, consisting of the six components of Porter's Value Agenda[5] and supplemented by the two concepts of patient-centred care[22] and shared decision-making,[7] together as one component.

The likelihood of success of the implementation of a VBHC strategy is also based on Porter's Value Agenda,[5] which indicates that a successful implementation is based on all six value agenda components but should at least include 'creating an integrated practice unit (IPU)' and 'measuring outcomes and costs for every patient'. Considering the importance of employing patient-reported outcome measures (PROMs), questionnaires used in studies incorporating the 'measure outcomes and costs for every patient' component were extracted. The operational military patient care pathway is based on the system of levels of care, from point of injury to definitive care, including rehabilitative care.[11 23] The entire dataset is presented in online supplemental material S5.[16]

Patient and public involvement

None.

RESULTS

Eligible studies

The final electronic searches occurred on 12 February 2024, and retrieved a total of 3214 individual references after removing duplicates. After title and abstract screening, 3127 articles were excluded because they did not meet the inclusion criteria. One article was not retrievable. 86 articles were eligible for full-text screening, after which we excluded 68 articles that met the exclusion criteria. 18 articles were eligible for inclusion in the final analysis. An overview of the article selection is shown in figure 1.

Study characteristics

In total, 18 studies were included in the final analysis (see table 1). The oldest was published in 2014. Twelve12 non-randomised studies included eight retrospective cohorts, two prospective cohorts and two cross-sectional studies. The other six qualitative studies included four descriptive studies, one case study and one observational study. Two groups of articles were identified: one regarding injury-related studies (n=15) and the other concerning studies with a system-level (ie, implementation of care-related elements with impact on a health system) approach regarding VBHC (n=3). Among the injury-related group, studies were clustered in amputation and extremity traumas, (mild) traumatic brain injury ((m) TBI), multiple traumas and other injuries (ie, injuries not covered by the other injury-related studies, but still related to war-injuries, eg, peripheral never injury and lung injury). Except for one study, all included studies addressed the postoperational definitive care phase (ie, definitive treatment after operational deployment due to injuries sustained during deployment) in the operational military patient care pathway. Also, two studies focused on the trauma/acute care phase during operational deployment.

Quality of included studies

Three out of six qualitative studies did not meet all items for qualitative study analysis. In all three articles, there was no coherence between qualitative data sources, collection, analysis and interpretation. In Johnston-Brooks *et al*,[24] the findings were not adequately derived from the data because, despite the clear explanation of the data sampling, no data were yet available for analysis. In Schaettle *et al*,[25] the interpretation of results was insufficiently substantiated by data because no data were provided that could be interpreted; only conclusions were given. All non-randomised studies had a consolidated score of 4 or more, with four out of 11 studies did not meet all items regarding non-randomised study analysis. In Eskridge *et al*[26] and MacGregor *et al*,[27] there was a lack of accounting for confounders in the design and analysis. Eskridge *et al*,[26] although mentioning no difference in demographic confounders, did not mention prosthetic type or how well the participants used their prosthetics. MacGregor *et al*[27] mentioned participant characteristics but did not account for these confounders in their final analysis. In Perkins *et al*,[28] the outcome data were not complete because not all participants completed the quality-of-life analysis. As in MacGregor *et al*,[29] there was no complete outcome data, which could be a limitation for including all factors that can lead to concussion. No

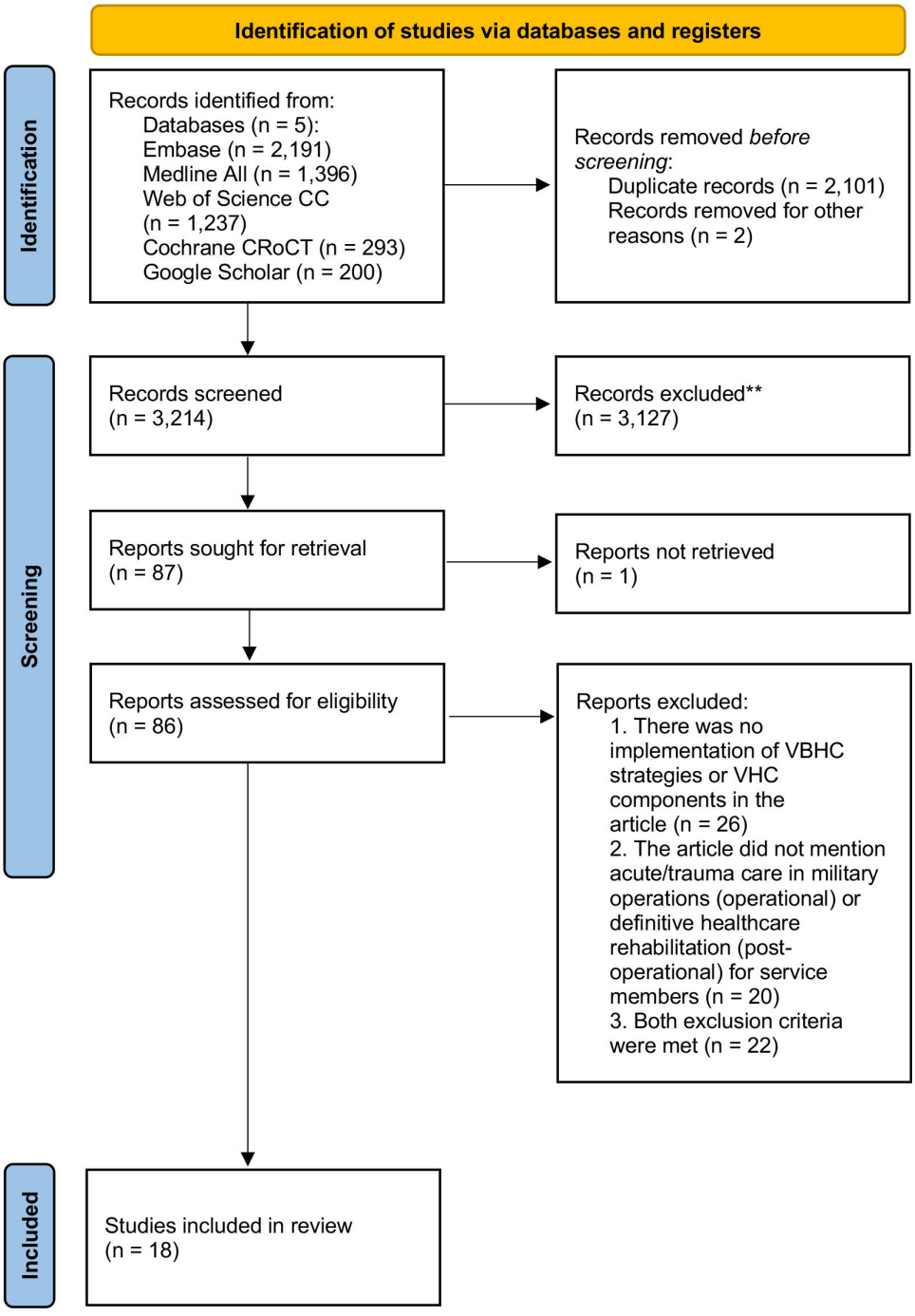

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram. Number of studies identified by search strategy, number of studies excluded and included during all screenings, and the final number of studies included. VBHC, value-based healthcare.

studies were excluded based on the MMAT scores. Online supplemental material S6 provides details on the scoring methodology and MMAT scores for each included study.[16]

Implementation of VBHC components

The term VBHC was only used in three of the 18 articles included in the study. However, it was observed that the key components are frequently integrated into the military medical chain. Overall, the 'measure outcomes and costs for every patient' component was most prevalent in the included studies (17/18). Patient-centred care/shared decision-making was second in prevalence, as it was mentioned in 8 out of 18 articles. Figure 2 shows the prevalence of all VBHC components, including patient-centred care, for all injury groups and the system group.

In none of the injury-related articles, 'build and enabling information technology platform' was mentioned and only in the multiple traumas cluster was one mention of 'integrate care delivery across separate facilities'. In the

Table 1 List of included studies and characteristics

Authors	Year	Study type	Country	Centre/Programme	Phase of care
Amputations and extremities					
Scott *et al*[38]	2014	Prospective cohort	USA	Joint Theatre Trauma Registry (JTTR)	Definitive
Stinner[39]	2016	Descriptive study	USA	Walter Reed Medical Center and University of Pittsburgh	Definitive
Perkins *et al*[28]	2018	Retrospective cohort	USA	Global War on Terror Vascular Injury Initiative (GWOT-VII)	Trauma/acute and definitive
Eskridge *et al*[26]	2019	Retrospective cohort	USA	Wounded Warrior Project (WWRP)	Definitive
Eskridge *et al*[40]	2020	Retrospective cohort	USA	Wounded Warrior Recovery Project (WWRP)	Definitive
Eskridge *et al*[41]	2022	Cross-sectional study	USA	Wounded Warrior Recovery Project (WWRP)	Definitive
(m)TBI					
Bolzenius *et al*[42]	2015	Cross-sectional study	USA	Saint Louis University	Definitive
Johnston-Brooks *et al*[24]	2021	Descriptive study	USA	Marcus Institute for Brain Health (MIBH)	Definitive
MacGregor *et al*[29]	2023	Retrospective cohort	USA	Wounded Warrior Recovery Project (WWRP)	Definitive
Multiple traumas					
MacGregor *et al*[27]	2020	Retrospective cohort	USA	Wounded Warrior Recovery Project (WWRP)	Definitive
MacGregor *et al*[43]	2021	Retrospective cohort	USA	Wounded Warrior Recovery Project (WWRP)	Definitive
Hawari *et al*[44]	2021	Retrospective cohort	USA	Wounded Warrior Recovery Project (WWRP)	Trauma/acute
MacGregor *et al*[45]	2021	Retrospective cohort	USA	Wounded Warrior Recovery Project (WWRP)	Definitive
Other injuries					
Wade *et al*[46]	2020	Observational study	USA	Walter Reed National Military Medical Center	Definitive
Hines *et al*[47]	2022	Prospective cohort	USA	Veterans Affairs, Toxic Embedded Fragment Registry	Definitive
Systems					
Galvin *et al*[48]	2019	Descriptive study	USA	Integrated Resourcing and Incentive System (IRIS), National Surgical Quality Improvement Programme (NSQIP) database and the Joint Outpatient Experience Survey (JOES)	Definitive
Taylor-Clark and Patrician[49]	2020	Case study	USA	N/a	Definitive
Schaettle *et al*[25]	2022	Descriptive study	USA	Tricare	Definitive

amputations and extremities cluster, we observed articles implementing five out of seven VBHC components. These included mentioning 'integrated practice units', 'measure outcomes and costs for every patient', 'move to bundled payments for care cycles', 'expand excellent services across geography' and 'patient-centred care/shared decision-making'. For the mTBI cluster, there was implementation of three out of seven VBHC components, including 'integrated practice unit', 'measure outcomes and costs for every patient' and 'patient-centred care/shared decision making'. In the multiple traumas cluster, there was implementation of three out of seven VBHC components, including 'measure outcomes and costs for every patient', 'integrate care delivery across separate facilities' and 'expand excellent services across geography'. The other injuries cluster had four out of seven VBHC components implemented regarding 'integrated practice units', 'measure outcomes and costs for every patient', 'expand excellent services across geography' and 'patient-centred care/shared decision making'. The prevalence or absence of the VBHC components by injury group and system group can be an indicator of the

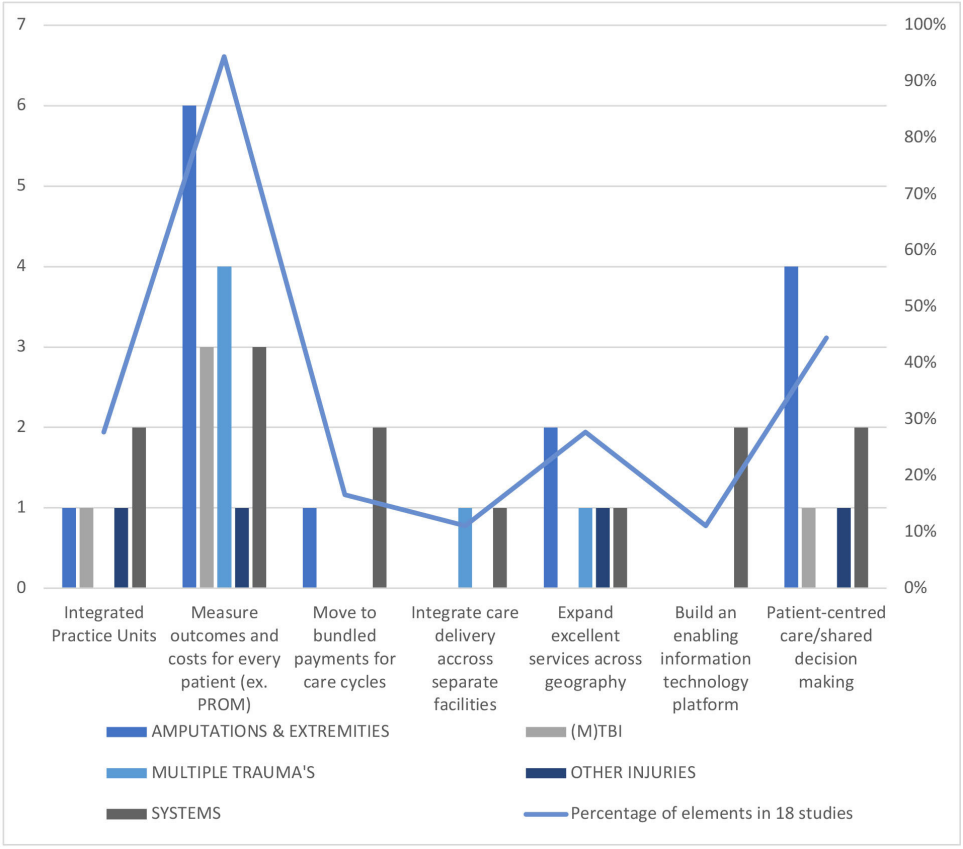

Figure 2 Prevalence of VBHC components. Overview of the prevalence of all VBHC components, including patient-centred care, for all injury groups and the system group. (m)TBI, (mild) traumatic brain injury; PROM, patient-reported outcome measure; VBHC, value-based healthcare.

potential applicability of VBHC in MHS. online supplemental material S7[16] provides an overview of the score matrix belonging to the dataset in .online supplemental material S5[16]

All studies that implemented PROMs used questionnaires to interpret their data. The (m)TBI group showed the greatest heterogeneity due to the use of 37 questionnaires in three studies, with 33 unique PROMs. Overall, the SF-36 (5/18), and QWB-SA (4/18) were the most used questionnaires. Table 2 and online supplemental material S8[16] present an overview and clarification of the questionnaires.

DISCUSSION

The aim of this systematic review was to provide an overview of the implementation of VBHC strategies and components within military trauma care, to help determine the feasibility of VBHC in MHS. Military medicine has existed for centuries, evolving following

Table 2 Illustrative overview of PROMs used per cluster

Injury-related and system-level studies	Included studies (n)	Used PROMs (n)	Overview used patient-reported outcome measures (PROMs)
Amputations and extremities	6	9	SF-36; QWB-SA; OPUS LEFS; CES-D; PLC-C
(M)TBI	3	37	SF-36; CES-D; NSI; PHQ-9; AUDIT; GAD-7; PCL-5; Neurobeh. Checklist; CRAFFT; DFAS; MIBH Mod.; DFAQ CU; DHI HIT-6; MFIS; Online OSU-TBI-ID; PC PTSD; PGIC; PSQI; WHODAS 2.0; PROMIS-Pain; Epworth Sleep Sc.; PHQ-15; GOAT; WMT; CWIT; WCST; CVLT; LDFR; BDI-II; BAI; BTBIS; PHQ-8; PHDA
Multiple traumas	4	10	SF-36; QWB-SA; CES-D; PLC-C; PDHA; WWRP; PHDA/RA
Other injuries	2	2	BTBIS; ATS-DLD-78
Systems	3	1	MOTION

(m)TBI, (mild) traumatic brain injury.

civilian medicine developments, but just as importantly, during military deployments, military medicine is widely being improved. In this context, the need to treat large volumes of wounded and sick remains a very important indicator of military medicine's success. Value-driven military healthcare therefore offers a very interesting perspective of comparing (health) value, seen as the best (long term) outcome for the combat injured or sick service member, against a logistic value chain, seen as the ability to get injured and sick service members going back home as soon as possible. From the perspective of measuring health outcomes, the added value of military medicine and MHS can be benchmarked. The quality of the operational military patient care pathway can be visualised by measuring the volume of care required based on geopolitical developments and by measuring the (long-term) health outcomes for the individual service member.

PROM implementation as a part of the 'measuring outcomes and costs for every patient' component is most prevalent (94%) in the included studies. In the amputations and extremities group, there was some consistency in the PROMs, as the OPUS-LEFS, SF-36 and QWB-SA were used in at least two or more out of six included studies. In the other injury and system groups, no consensus could be found in the use of PROMS. Furthermore, the VBHC component 'building and enabling information technology platform' was not named in the injury groups. Not using the term 'building and … technology platform' does not take away the fact that digitalisation has been accelerating and integrating into healthcare systems at a fast pace for decades. The time span (2014–2023) of the included studies also shows exponential growth in the use and significance of IT platforms. Part of the aim of this digitalisation is to achieve objective reproduction, control of data and a good balance in security and privacy.[30 31] We recognise that IT platforms are present in the included studies, but not named as such.

The second VBHC component seen as a basic element for a successful implementation is 'creating an integrated practice unit (IPU)'. This component has shown itself in three studies in the injury-related groups and two studies in the systems group. It is interesting to observe that all five studies saw the integrated (multidisciplinary) approach as the basis for the best treatment of the patient, with three studies even explicitly referring to the VBHC component 'IPU' as the way for the complete set of treatment, including the patient as part of his/her treatment process.

Overall, the applicability or implementation of VBHC is seen as promising for the following groups: (1) amputations and extremities, (2) (m)TBI and (3) military healthcare systems. In the 'multiple trauma' and 'other injuries' groups, applicability is less promising. Particularly because VBHC assumes implementation around a single clinical condition vs the prevalence of multi-trauma injuries within military medicine. Finally, the previous shows that the implementation of VBHC components is fragmented in military medicine and in existing policies, but also without labelling it as part of the VBHC concept.

This systematic review will be the first review that has examined the implementation of VBHC (components) in military medicine. The search showed articles in the period from 1946 to 2023, looking at applicability around injuries and systems, taking place at different points in the soldier/patient care pathway. The included studies showed that the first adoption of VBHC was found in a 2008 study. A further observation is that all the included studies originated from the USA, most data originated from the Wounded Warrior Recovery Project. A good example of similar research is the ongoing 'Dutch Battle Field Casualties NL' study on the long-term impact of battle injuries, looking at the 5-year follow-up of injured servicemen in Afghanistan[32] and with the 10-year follow-up forthcoming including, but not limited to, PROMs, measurement of costs and family relationships.[33 34]

In 2024, a collaborative effort led by ICHOM, with support from Dutch and Australian sponsors, is set to launch a project aimed at developing a set of patient-centred outcome measures exclusively tailored to Trauma. As a result, the set will contribute to, among other things, quality improvement and benchmarking in civilian and military clinical trauma practice.

The above applications of VBHC-type components lead to the consideration of whether VBHC should have a role in the MHS. The following consideration is important, namely the desire and or need to conduct long-term research on the applicability of VBHC in operational military medicine. Such research should have a focus on the treatment of trauma and multi-trauma injuries. It is also relevant to conduct additional research on the applicability of VBHC (-components) among a large group of international armed forces. Implementation of VBHC can lead to better patient outcomes and higher quality of care in this regard.

Limitations

Limitations of this study concern the broadening of the scope of the operational military patient care pathway from active-duty military personnel to active-duty military personnel as well as veterans. This broadening focuses on the close connection between the US military healthcare system and the US veteran healthcare system. Within the USA, there is an explicit connection between the systems.[35 36] The other limitation does not affect the review itself and the outcomes but should be named from the perspective of military operational deployment. In particular, the included studies focused on wounded soldiers from military missions in Iraq and Afghanistan. These missions, conducted over the past 20 years, show that VBHC components can contribute to the best outcome for the wounded service member. However, current international developments show a preparation for more large-scale combat operations with possibly different approaches to achieve the best outcome for the combat-injured service member.[37]

Conclusions

This systematic review showed the application of VBHC components in military medicine, and MHS. However, the use of standard VBHC terminology was not consistently applied. Despite this, this study suggests that the implementation of VBHC as a concept in military healthcare, could enhance benchmarking to provide insight in health outcomes, and overall quality of care. Military health outcomes both clinically reported and patient-reported—including from a (multi-)trauma perspective—are essential as a fundamental element for military medicine and MHS. Future research on the application of VBHC should at least reflect this starting point.

Contributors HvdW conceived the study. HvdW and DD planned and designed the study. JAH and RH supervised and approved the scope and design of the study. MFME, HvdW and DD performed the literature search and data quality assessment. HvdW, DD, RH and JAH analysed and interpreted the data and screened the articles on eligibility. HvdW and DD performed the data extraction. HvdW drafted an initial version of the manuscript. MFME, RH and JAH were involved in advising on the Introduction, Methods and Discussion sections. HvdW, DD, MFME, RH and JAH were involved in drafting the final version of the manuscript, including the critical review of the manuscript and approved the final version of the manuscript. JAH is the guarantor.

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