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How to improve efficiency in cancer care: Dimensions, methods, and areas of evaluation

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ABSTRACT

Efficiency in healthcare is crucial since available resources are scarce, and the cost of inefficient allocation is measured in prior outcomes. This is particularly relevant for cancer. The aim of this paper is to gain a comprehensive overview of the areas and dimensions to improve efficiency, and establish the indicators, different methods, perspectives, and areas of evaluation, to provide recommendations for how to improve efficiency and measure gains in cancer care.

Methods: We conducted a two-phase design. First, a comprehensive scoping literature review was conducted, searching four databases. Studies published between 2000 and 2021 were included if they described experiences and cases of efficiency in cancer care or methods to evaluate efficiency. The results of the literature review were then discussed during two rounds of online consultation with a panel of 15 external experts invited to provide insight and comments to deliberate policy recommendations.

Results: 46 papers met the inclusion criteria. Based on the papers retrieved we identified six areas for achieving efficiency gains throughout the entire care pathway and, for each area of efficiency, we categorized the methods and outcomes used to measure efficiency gain.

Conclusion: This is the first attempt to systemize a scattered body of literature on how to improve efficiency in cancer care and identify key areas of improvement.

Policy summary: There are many opportunities to improve efficiency in cancer care. We defined seven policy recommendations on how to improve efficiency in cancer care throughout the care pathway and how to improve the measurement of efficiency gains.

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1. Introduction

Efficiency is concerned with the relation between resource inputs and either intermediate outputs or final health outcomes [1]. Despite this definition of efficiency being beguilingly simple, putting this notion into practice can be complex. Efficiency cannot easily be considered as a synonym of cost containment, and a goal in itself but a means to deliver what matters most to patients and to society overall. Indeed, the opportunity cost of an inefficient allocation is measured in health prior outcomes. Therefore, efficiency in healthcare is crucial, and to attain this goal, the attempt should be to improve both allocative and technical efficiency. These are two common measures used in economics, and also in this paper, to examine whether the correct mix of health services is funded or provided, so that at any given level of total expenditure, health outcomes are maximized; and to examine how to maximize the outputs given an existing level of inputs (technical efficiency) [2].

Improving efficiency in healthcare is also complex because, within health systems, there is a seemingly infinite set of interlinked processes that could independently be evaluated and found to be efficient or inefficient [2].

Where estimates exist for OECD countries, these suggest that approximately 20 % of healthcare spending is currently wasted on ineffective or inefficient interventions [3]. Examples of inefficiency can be detected at all levels [4]: at system, the provider and the patient level.

All these inefficiencies can lead to considerable avoidable costs for healthcare systems, for patients and for society as a whole, and poor health outcomes in terms of premature mortality, and reduced quality of life [4]. This is also relevant for cancer. In fact, cancer, is the second main cause of death in European countries, accounting for 26 % of all deaths in 2017 [5] and a large and increasing component of total health care spending. Cancer care is responsible for 5–7 % of healthcare costs in Europe, having reached approximately €103 billion per year in 2018, which rises to €199 billion if costs incurred outside the health-care system are also considered [6]. These costs are in line with the estimates of the total cost of cardiovascular disease in the EU-28 which amounted to €210 billion in 2015 [6]. The expectation, however, is that cancer costs are expected to rise faster than other related areas of healthcare [7], driven not only by an aging population, increasing incidence, as well as better survivorship, treatment innovations, and overutilization [6,8,9], but also by the lack of suitable clinical and health-service research, and integrated health economic studies, that might define the most efficient way to deliver, and improve delivery, of evidence-based care [9]. In addition, studies are starting to show how delayed cancer diagnoses and treatment due to the Covid-19 pandemic are likely to increase cancer deaths, cancer burden, and consequently, cancer costs [5]. Given that affordability and healthcare budgets are not limitless, cutting inefficiencies free resources that can be allocated to respond to the increasing needs of patients' [10] and deliver better care. There are many ways to improve efficiency in cancer care. A large international survey by the multistakeholder initiative All.Can [4] identified four priority areas for efficiency improvement from a patient perspective, namely: i) to ensure a swift, accurate, and appropriately delivered diagnosis; ii) to improve information sharing, support, and shared decision making; iii) to make integrated multi-professional care a reality for all patients; and iv) to address the financial implications of cancer [11]. Based on these premises, the objective of this work was to gain a comprehensive overview of the areas and dimensions to improve efficiency in cancer care, and what the indicators, different methods, perspectives, and areas of evaluation are, to provide recommendations on how to improve efficiency in cancer care and how to measure efficiency gains.

2. Methods

To reach these objectives, we carried out a two-phase design project as part of a broader project that SDA Bocconi developed in partnership with SPCC (Sharing Progress in Cancer Care) and All.Can on Improving Efficiency in Cancer Care.

2.1. Phase 1: literature review

First, a comprehensive scoping literature review was conducted following Arksey and O'Malley's framework for scoping reviews [12] to synthetize the up-to-date body of literature on how to improve efficiency in cancer care and identify key areas of evaluation. We adopted the scoping review methodology since the purpose of the review was to provide an overview of the diverse body of existing literature pertaining to a broad topic such as efficiency in cancer care. Therefore, we provide a narrative overview of the reviewed materials without critically appraising individual studies and evaluating the quality of evidence [12, 13].

2.1.1. Data sources and search strategy

We searched four peer reviewed electronic databases that cover a broad range of disciplines: MEDLINE/PubMed, Science Direct, EconLit, and SpringerLink. We limited the search to articles published between 2000 and 2021. We also adopted a "snowball" technique where citations within articles were searched if they appeared relevant to the review, and we searched specific websites, reference lists, key journals, and grey literature databases for relevant materials (see Supplementary Materials).

2.1.2. Eligibility criteria

A three-stage screening process was used to assess the relevance of studies identified in the search. Studies were eligible for inclusion if they broadly described and reported experiences and cases of efficiency in cancer care or methods to evaluate efficiency in cancer care. We included articles that focused on the entire cancer care pathway or on specific phases of the care pathway.

We defined the cancer care pathway as the complex intervention for the mutual decision making and organization of care processes for a well-defined group of patients during a well-defined period [14,15]. We therefore included all activities from symptom onset, to diagnosis, to treatment, to follow-up (discharge from the hospital and after-care), to palliative, survivorship, and end-of-life care. It includes the logistic management of care processes within a care unit that can be a health center, an outpatient clinic, a day care center, a laboratory, a radiology department, an operating room, or a nursing ward. We analyzed efficiency at all levels: system, provider, and patient.

Papers were excluded from the analysis if there were no full texts available, if they focused on a single technology (e.g., cost effectiveness analysis of specific medical devices) or on experiences implemented only in low-income countries.

Due to the high number of citations retrieved, the first level of screening focused only on titles. For the second level of screening, one author (LF) reviewed titles and abstracts and shared the results with two other authors (MO and RT) throughout the screening process to discuss any uncertainties related to studies selection. Finally, all relevant citations were retrieved for full-text review.

2.2. Phase 2: discussion with an expert panel group

Following the literature review, a multidisciplinary group of 15 international experts convened for two rounds of online workshops during 2021. A mixed approach was employed for the workshops, and subsequent activities centered on the Nominal Group Technique (NGT) consensus development method [16]. In fact, the NGT is one of the most indicated methods to structure interaction within the group by collecting all differing opinions and encouraging the generation of multiple ideas. The workshops were conducted virtually, and the encounters were recorded and transcribed by one facilitator. Participants received the material to be discussed in advance. During the workshops, the

facilitators provided an overview of the material to be discussed, subsequently soliciting responses in a round-robin format from the group until all ideas and comments had been voiced and discussed. Participants were encouraged to contribute to the discussion either before or after the workshop by e-mail.

The first workshop aimed to validate research questions and methodology, discuss the preliminary findings of the literature review, provide insight and comments on the review, plus identify relevant literature (e.g., other papers and grey literature) and topics that were not included. After the first workshop, the review was updated and a revised version of the briefing paper was circulated, containing additional information requested during the first workshop, along with nascent versions of recommendations. The second workshop aimed to discuss the results of the literature review and deliberate policy recommendations. It began with an overview of new evidence and research results, followed by discussion and validation of recommendations for each of the research question areas. Finally, a draft manuscript containing final recommendations and underlying reasoning and evidence was circulated among participants for comments, then revised and recirculated for final approval.

3. Results

3.1. Data extraction: search and study selection

The search yielded 101,634 potentially relevant citations (94,469 identified through PubMed, 6000 through ScienceDirect, 165 through EconLit, 1000 through SpringerLink) and ten additional records identified by the expert panel. After de-duplication and first relevance screening (based on title review), we excluded 95644 citations, so 747 citations were screened. 250 citations met the eligibility criteria based on title and abstract, and the corresponding full-text articles were procured for review. After data characterization of the full-text articles, 46 articles were included in the analysis. The flow of articles through identification to final inclusion is represented in Fig. 1. The following table (Table 1) presents an overview of the 46 papers included in the analysis, summarizing their aim, the country, the tumor site, the cancer type, the area of efficiency improvement, and the perspective of the analysis adopted by each paper (system, provider, patient). The following three sections provide a summary of the results for the three research questions of the paper: Firstly, what are the areas and dimensions to improve efficiency? (Section 3.2); Secondly, what are the areas, methods and data considered to measure and report efficiency gains? (Section 3.3); Thirdly, what are the metrics to evaluate efficiency? (Section 3.4). The results and discussion that follow incorporate the results of the literature review and the perspective of the expert panel as these cannot be considered separate.

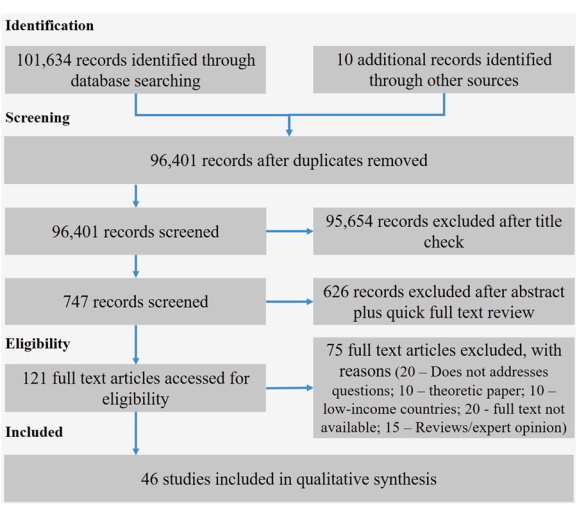

Fig. 1. PRISMA.

3.2. Areas and dimensions of efficiency

We identified six areas for achieving efficiency gains (Fig. 2) throughout the entire care pathway that were categorized as follows:

1. **Process management:** this includes all the tools and resources that focus on the patient journey as the primary improvement focus. It aims to analyze, define, optimize, and monitor care processes [15] to identify and eliminate non-value-adding steps in the patient journey [63] for driving improved performance of interdependent processes. Process redesign change starts with the definition of integrated care pathways (ICPs), protocols, the use of operation management tools, lean management, package solutions, and risk management tools.
2. **Integrated Service Delivery (ISD):** this includes models of care such as Integrated Practice Unit (IPU) or Centre or Unit [64] organized around a specific need or medical condition. Paradigmatic examples include the set-up of a one-stop-shop model, multidisciplinary clinic, specialist unit or clinical service line. To a large extent, the distinctive element of the experiences included under this area is that care is co-located in specific facilities with unified scheduling, with a dedicated, multidisciplinary, and professional team devoting a significant portion of their time to the medical condition [65].
3. **Human Resource Management (HRM)**: this includes collaboration between healthcare professionals (i.e., a multidisciplinary team) and the workforce redesign (skill-mix change) to use resources more effectively and efficiently.
4. **Data analytics:** this includes the data collection, use of data (e.g., big data and real-world data), artificial intelligence (AI), machine learning, computerized decision support, and stratification tools to support decision-making and draw conclusions.
5. **Information and communication technology (ICT) and technology**: this area covers the role of ICT and technology (e.g. mHealth, apps, eHealth, online consultations) which has the potential to impact on service delivery costs while improving health outcomes.
6. **Financing:** this includes value-based reimbursement schemes (namely episode-based payment, bundled payment, pay-for-performance, pay for coordination) and strategies to reward providers for improving the coordination, quality, and efficiency of care.

Based on the classification adopted, 37 % of studies reported process management improvements, 22 % of studies reported ISD changes, 15 % of studies reported changes connected to data analytics, 13 % of studies reported improvements that leverage on HRM, 9 % of studies reported ICT and technology improvements, and 4 % of studies reported improvement in financing.

3.3. Areas, methods, and data considered

Fig. 3 shows, for each area of efficiency identified, the study design, methods used to measure efficiency, and data considered. The methods developed are quite similar across all areas of efficiency. The authors mostly adopted observational studies, often retrospective ones, to report efficiency gains. Most of the papers (76 %) did not report any analysis of costs and resource use, and only 24 % of studies reported partial economic evaluation [66] which focused solely on costs and resource use, and did not make explicit comparisons between alternative interventions in terms of both costs and outcomes. The area of process management shows the highest variety of methods, including specific methods to improve quality, such as Plan Do Check Act (PDCA), Data Envelopment Analysis (DEA), Six Sigma, and Pareto Analysis.

Table 1
Detailed list of eligible articles from the literature search.

Reference	Aim of the paper	Country	Cancer type	Efficiency Area	Phases of care	Perspective
van Agthoven et al. [17]	Compliance and efficiency before and after implementation of a clinical practice guideline for laryngeal carcinomas	Netherlands	Head & neck	Process management	All care process	Provider
(Al Hroub et al. 2019)[18]	Improving the Workflow Efficiency of An Outpatient Pain Clinic at A Specialized Oncology Centre by Implementing Lean Principles	Jordan	All	Process management	All care process	Patient
Carlson et al. [19]	A multidisciplinary model of care for childhood cancer survivors with complex medical needs	USA	Pediatric	Integrated Service Delivery	All care process	Provider and Patient
Chin et al. [20]	Reducing otolaryngology surgical inefficiency via assessment of tray redundancy	Canada	ORL	Process management	Treatment	Provider
Choudhury et al. [21]	A multidisciplinary audit of head and neck referrals: considerations for patients' timelines and outcomes	UK	Head & neck	Integrated Service Delivery	All care process	Provider
Clarke et al. [22]	New geographic model of care to manage the post-COVID-19 elective surgery aftershock in England: a retrospective observational study	UK	All	Data analytics	Treatment	System
Coelho et al. [23]	Process Improvement in a Cancer Outpatient Chemotherapy Unit using Lean Healthcare	Brazil	All	Process management	Treatment	Provider
Colasante et al. [24]	A multidisciplinary group for prostate cancer management: A single institution experience	Italy	Prostate	Human Resource Management	All care process	Provider and Patient
Collins et al. [25]	Home-based telehealth service for swallowing and nutrition management following head and neck cancer treatment	Australia	Head & neck	Information and communication systems	Follow up	Provider and Patient
Conant et al. [26]	Improving Accuracy and Efficiency with Concurrent Use of Artificial Intelligence for Digital Breast Tomosynthesis	USA	Breast	Data Analytics	Diagnosis	Provider
Coyle et al. [27]	Model for the cost-efficient delivery of continuous quality cancer care: a hospital and private-practice collaboration	USA	All	Integrated Service Delivery	All care process	Provider
Damato et al. [28]	Redesign of process map to increase efficiency: Reducing procedure time in cervical cancer brachytherapy	USA	Cervical	Process management	Treatment	Provider
Del Vecchio Blanco et al. [29]	Clinical care pathway program versus open-access system: a study on appropriateness, quality, and efficiency in the delivery of colonoscopy in the colorectal cancer	Italy	Colorectal cancer	Process management	All care process	Provider
Fasola et al. [30]	Adopting integrated care pathways in non-small-cell lung cancer: from theory to practice	Italy	Lung cancer	Process management	All care process	Provider
Feng and Antony [31]	Integrating DEA into Six Sigma methodology for measuring health service efficiency	USA	Gynecological	Process management	All care process	Provider
Forshaw et al. [32]	Centralisation of esophagogastric cancer services: can specialist units deliver?	UK	Esophagogastric	Integrated Service Delivery	All care process	Provider
Franken et al. [33]	Hospital-based or home-based administration of oncology drugs? A micro-costing study comparing healthcare and societal costs of hospital-based and home-based subcutaneous administration of trastuzumab	Netherlands	Breast	Integrated Service Delivery	Treatment	Provider and Patient
French et al. [34]	Continuous Quality Improvement Measured with Time-Driven Activity-Based Costing in an Outpatient Cancer Surgery Centre	USA	All	Process management	All care process	Provider
Hall et al. [35]	Costs of cancer care for use in economic evaluation: a UK analysis of patient-level routine health system data	UK	Several	Data analytics	All care process	Provider
Hallquist et al. [36]	Positive impact of genetic counselling assistants on genetic counselling efficiency, patient volume, and cost in a cancer genetics clinic	USA	Breast	Human Resource Management	Diagnosis	Provider
Hanna et al. [37]	Implementation of Digital Pathology Offers Clinical and Operational Increase in Efficiency and Cost Savings	USA	All	Data analytics	All care process	Provider
Head, et al. [38]	Innovative practice model to optimize resource utilization and improve access to care for high-risk and BRCA+ patients	Canada	Breast	Process management	All care process	Provider
Hellingman et al. [39]	Optimization of transmural care by implementation of an online expert panel to assess treatment strategy in patients suffering from colorectal cancer liver metastases: A prospective analysis	Netherlands	Colorectal cancer	Information and communication systems	Diagnosis	Provider
Hernandez-Boussard, et al. [40]	Leveraging Digital Data to Inform and Improve Quality Cancer Care	USA	All	Data analytics	All care process	Provider
Ho et al. [41]	Can digital pathology result in cost savings? A financial projection for digital pathology implementation at a large integrated health care organization	USA	Several	Data analytics	Diagnosis	Provider
Johnston and Gerard [42]	Assessing efficiency in the UK breast screening programme: does size of screening unit make a difference?	UK	Breast	Integrated Service Delivery	All care process	Provider
Ju et al. [43]	Multidisciplinary Teams Improve Gastric Cancer Treatment Efficiency at a Large Safety Net Hospital	USA	Gastric cancer	Process management	All care process	Provider
(Kedia et al. 2015)[44]	'One-stop shop': lung cancer patients' and caregivers' perceptions of multidisciplinary care in a community healthcare setting	USA	Lung cancer	Integrated Service Delivery	All care process	Patient
Keehn et al. [45]	Same-Day Surgery for Mastectomy Patients in Alberta: A Perioperative Care Pathway and Quality Improvement Initiative	Canada	Breast	Process management	Treatment	Provider andPatient
Kyono, et al. [46]	Improving Workflow Efficiency for Mammography Using Machine Learning	UK	Breast	Data analytics	Diagnosis	Provider

(*continued on next page*)

Table 1 (*continued*)

Reference	Aim of the paper	Country	Cancer type	Efficiency Area	Phases of care	Perspective
Yetzer et al. [47]	Clinical Pathway Implementation Improves Efficiency of Care in a Maxillofacial Head and Neck Surgery Unit	USA	Head & neck	Process management	All care process	Service
(Lin et al. 2014) [48]	Development and application of telephone counselling services for care of patients with colorectal cancer	Taiwan	Colorectal Cancer	Information and communication systems	Follow up	Patient
Ooi et al. [49]	'One stop' haematuria clinic in Fremantle Hospital, Western Australia: a report of the first 500 patients	Australia	Urological	Integrated Service Delivery	All care process	Provider
Ma et al. [50]	Capacity planning and appointment scheduling for new patient oncology consults	Canada	All	Process management	All care process	Provider
Mahony et al. [51]	The Impact of Breast Care Nurses: An Evaluation of the McGrath Foundation's Breast Care Nurse Initiative	Australia	Breast	Human Resource Management	All care process	Provider and Patients
McHugh et al. [52]	Health workforce planning and service expansion during an economic crisis: A case study of the national breast screening programme in Ireland	Ireland	Breast	Human Resource Management	Diagnosis	Provider
Parkes et al. [53]	Successful Implementation of a Multidisciplinary Chemotherapy Efficiency Initiative at a Community Hospital	USA	All	Process management	Treatment	Provider andPatient
Ryan et al. [54]	Evaluation of clinical pharmacists' follow-up service in an oncology pain clinic	Canada	All	Human Resource Management	Follow up	Professionals and Patients
Scotté et al. [55]	A practical approach to improve safety and management in chemotherapy units based on the PROCHE – Programme for optimisation of the chemotherapy network monitoring program	France	All	Information and communication systems	Treatment	Provider and Patients
Sorensen et al. [56]	A "package solution" fast track program can reduce the diagnostic waiting time in head and neck cancer	Denmark	Head & neck	Process management	Diagnosis	Provider
Spahlinger et al. [57]	New organizational and funds flow models for an academic cancer center	USA	All	Financial	All care process	Service
Trepanier and Allain [58]	Models of service delivery for cancer genetic risk assessment and counselling	USA	Breast	Integrated Service Delivery	Diagnosis	Professionals
van Lent et al. [59]	Improving the efficiency of a chemotherapy day unit: applying a business approach to oncology	Netherlands	All	Process management	Treatment	Service/Patient
Vitikainen et al. [60]	Substituting inpatient for outpatient care: what is the impact on hospital costs and efficiency?	Finland	All	Integrated Service Delivery	All care process	Provider
Walling et al. [61]	Effect and Efficiency of an Embedded Palliative Care Nurse Practitioner in an Oncology Clinic	USA	Breast	Human Resource Management	All care process	Service
Wang et al. [62]	Association of a Bundled-Payment Program with Cost and Outcomes in Full-Cycle Breast Cancer Care	Taiwan	Breast	Financial	All care process	Service

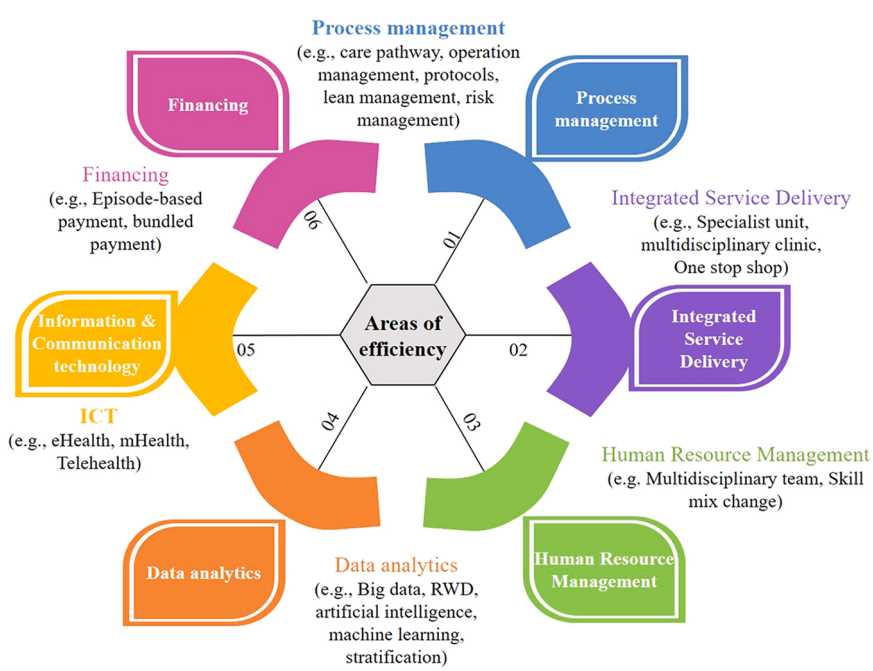

Fig. 2. Areas for achieving efficiency gains.

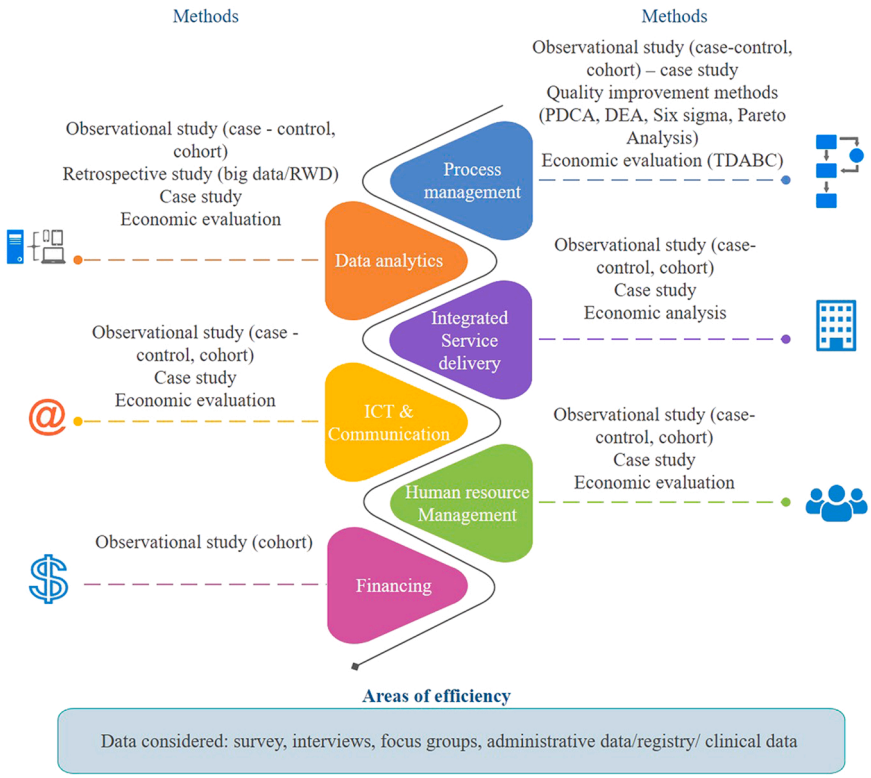

Fig. 3. Areas, methods and data considered.

3.4. Metrics to evaluate efficiency gains

Using the scale developed by Dodd and colleagues in 2018 for outcome classification [67] in Table 2 we categorize the outcome measures reported in the included studies according to the core area and outcome domain. Examples of outcomes within each of these domains and the reference to the papers are also provided.

81 % of studies include at least one indicator. 76 % of studies report outcomes related to the life impact core area and, especially, (73 %) to the "delivery of care" domain which contains several variables linked to health care interventions, including waiting times, time to perform specific procedures, and satisfaction. 65 % of studies report outcomes related to the "resource use" domain which includes general outcomes not captured within other specific resource use domain (e.g., cost, and resource use), outcomes related to inpatient stay, medication, and the need for further intervention, plus outcomes relating to financial burden on patients and caregivers. 8 % of studies include outcomes related to the "adverse events" domain, while only two studies report outcomes related to the "mortality/survival" domain.

4. Discussion

The purpose of this paper is to provide a comprehensive overview of the dimensions where efforts have been made to improve efficiency in cancer care, and how those efficiency gains are measured. The results show that there is a rich and worldwide debate in the literature surrounding the concept of efficiency in cancer care. 37 % of retrieved papers focus on experiences developed in the USA, 24 % in EU Countries (Netherlands, Italy, Ireland, and Denmark), 13 % in the UK, and 26 % in the rest of the world (Canada, Australia etc).

4.1. What are the areas and dimensions to improve efficiency?

Based on the papers retrieved, we have identified six areas for achieving efficiency gains throughout the entire care pathway, and within each single area, we have categorized single initiatives and activities for improvement. The results show that the most prevalent areas where efficiency gains are reported in the literature are the "process management area", the "ISD area", and the "data analytics area". These areas cover several topics where studies and publications are today most achievable but also more developed, confirming the mature and vivid debate in the last 10 years surrounding the value-based agenda, [65] the effectiveness and efficiency of ISD, clinical networks, and oncological care pathways by focusing on continuity of care and evidence-based patient care [68,69]. However, we also identified other areas where efficiency gains are likely to emerge, more predominantly, in the near future and where the debate is still emerging and relatively young. This is the interest and focus on the use of data and new technology. In fact, 70 % of papers reporting investment in this area have been published just in the last two years. The studies belonging to this improvement area support the use of real world data (RWD) and new technology as a strategy to improve efficiency in cancer care by fostering collaboration between surgical centers and a better distribution of workload [22]; shortening the time to perform specific activities while maintaining or improving accuracy [26]; or generating new patient-centered evidence of oncological care that can better guide treatment decisions and patient-valued care [40].

As emerged from the panel discussion, these results have two main implications: first, the six areas identified should not be considered in isolation. In fact, improvement interventions often have an impact on several areas at the same time and on the entire care pathway. In line with what has already been discussed by other studies [4,70,71], this confirms that efficiency gains can be achieved if the entire care pathway from symptom onset to end of life is considered, if all stakeholders involved in the care process collaborate throughout the care pathway, if the silo mentality is abandoned, and evidence-based practice is identified (See Recommendation 1, 2 and 3). Indeed, as a recent cost-effectiveness analysis has shown patients treated in audited/certified cancer centers not only survive longer than patients in non-certified hospitals, but also cost less, despite the greater resource commitment

Table 2
List of outcome categories/domains from the included studies.

Core area	Outcome domain & Examples of outcomes	Areas of efficiency improvements					
		Process management	Integrated Service Delivery	Human Resource Management	Data analytics	Information and communication systems	Financial
Life impact	**Global quality of life**						
	• PROMs				Hall et al. [35]		
	Delivery of care						
	• Accessibility (e.g., median nr of cases)				Clarke et al. [22]		
	• Appropriateness (e.g., prescription, referral; intervention)	van Agthoven et al. [17]; Del Vecchio Blanco et al. [29]; French et al. [34]	Choudhury et al. [21]; Johnston et al. [42]		Ho et al. [41]		Wang et al. [62]
	• Attendance rate	Del Vecchio Blanco et al. [29]		McHugh et al. [52]			
	• Patient satisfaction	Al Hroub et al. [18]; Keehn et al. [45]; Parkes et al. [53]; van Lent et al. [59]	Carlson et al. 2008 [19]	Colasante et al. [24]; Ryan et al. [54]; Mahony et al. [61]		Collins et al. [25]; Lin et al. [48]	
	• Performance (e.g., sensitivity/specificity)				Conant et al. [26]; Kyono et al. [46]		
	• Professional satisfaction			Ryan et al. [54]; Mahony et al. [61]	Hanna et al. [37]		
	• Quality of information given			Colasante et al. [24]			
	• Time to perform specific procedures (e.g., reading time)	Chin et al. [20]; Ju et al. [43]; van Lent, et al. [59]	Trepanier and Allain [51]	Colasante et al. [24]; Mahony et al. [61]	Conant et al. [26]		
	• Waiting times (e.g., time to diagnosis, time to treatment, time to medical report)	Al Hroub et al. [18]; Del Vecchio Blanco et al. [29]; Fasola et al. [30]; Ju et al. [43]; Head, et al. [38]; Ma et al. [50]; Sorensen et al. [56]; Damato et al. [28]; Parkes et al. [53]; van Lent et al. [59]	Choudhury et al. [21]; Forshaw et al. [32]; Ooi et al. [49]; Trepanier and Allain [51]	Colasante et al. [24]			
	• Workflow		Trepanier and Allain [51]		Ho et al. [41]		
Resource use	**Economic**						
	• Costs (e.g., hospital days, outpatient visits, day care visits, consultations, etc.)	van Agthoven et al. [17]; Feng and Antony [31]; French et al. [34]; Parkes et al. [53]	Franken et al. [31]	Hallquist et al. [36]; McHugh et al. [52]; Mahony et al. [61]	Hall et al. [35]; Ho et al. [41]	Collins et al. [25]	Spahlinger et al. [57]; Wang et al. [62]
	• Resource use (e.g., number of visits, surgery, procedures, etc.)	van Agthoven et al. [17]; Fasola et al. [30]; Feng and Antony [31]; Head et al. [38]; Ju et al. [43]; Ma et al. [50]; Parkes et al. [53]; van Lent et al. [59]	Forshaw et al. [32]; Franken et al. [33]; Ooi et al. [49]	McHugh et al. [52]; Ryan et al. [54]; Mahony et al. [51]		Scotté et al. [55]	Wang et al. [62]
	• Time of professionals		Franken et al. [33]; Trepanier and Allain [58]				
	• Volume (e.g., number of patients)	van Lent, et al. [59]					
	Hospital						
	• Admission rate (e.g., hospital, ED, ICU, other facilities)		Coyle et al. [27]; Forshaw et al. [32]	Walling et al. [61]; Mahony et al. [51]			
	• Average length of stay	French et al. [34]; Yetzer et al. [47]	Coyle et al. [27]; Forshaw et al. [32]; Franken et al. [33]	Hallquist et al. [36]; Walling et al. [61]		Scotté et al. [55]	
	• Consultation length		Trepanier and Allain [58]	Mahony et al. [51]		Collins et al. [25]	
	Need for further intervention						
	• Reassessments	van Agthoven et al. [17]	Choudhury et al. 2013[21]; Trepanier and Allain 2014[58]			Collins et al. [25]	
	• Recall rate in noncancers				Conant et al. [26]		

(continued on next page)

Table 2 (*continued*)

Core area	Outcome domain & Examples of outcomes	Areas of efficiency improvements					
		Process management	Integrated Service Delivery	Human Resource Management	Data analytics	Information and communication systems	Financial
	• Referrals	Sorensen et al. [56]; Yetzer et al. [47]	Carlson et al. [19]; Choudhury et al. [21]; Kedia et al. [44]	Walling et al. [61]		Hellingman et al. [39]; Collins et al. [25]	
	Societal/carer burden						
	• Societal costs (e.g., travel reimbursement, travel expenses, informal care, etc.)		Franken et al. [33]; Trepanier and Allain [58]				
Adverse events	**Adverse events / effects**						
	• Interpretative errors				Ho et al. [41]		
	• Postoperative morbidity/ complications	Yetzer et al. 2017[47]	Forshaw et al. [32]	Mahony et al. [51]			
	• Readmissions	Keehn et al. [45]; Yetzer et al. [47]		Mahony et al. [51]			
Death	**Mortality/survival**						
	• 30-day mortality		Forshaw et al. [32]				
	• Event- free and overall survival						Wang et al. [62]
	• in-hospital mortality		Forshaw et al. [32]				

required [72]. Second, most studies on efficiency also included analysis of the impact on effectiveness of the system, the quality of care, user and patient satisfaction, and the system's usability. This is relevant because by focusing on improving efficiencies we can fuel effectiveness, patient safety, responsiveness/patient-centeredness, appropriateness, timeliness, access and equity [73] at the same time.

4.2. What are the areas, methods and data considered to measure and report efficiency gains?

The second objective of the paper is to understand what the perspective of the analysis is, and what the methods to measure efficiency gains are. Today, the analysis of the effects of improvement initiatives has predominantly taken place at an organizational level and has been from a provider perspective. In truth, despite a growing debate in the literature around patient participation and involvement [74] and how such engagement can lead to reduced hospital admissions, improved efficiency, effectiveness, and quality of health services [75, 76], only a limited number of papers (17 %) systematically included patients' perspectives in the analysis [19,24,25,33,44,45,48,53]. The panel agrees that there are many areas where patient involvement and engagement can be implemented and there is a variety of ways to realize this (See Recommendation 4).

All papers have used observational studies as their study design, either cohort or case control studies. No experimental studies were reported in the included papers. PDCA, DEA, Six Sigma and Pareto analysis are often used as methods to support quality improvements within the process management area. These are effective methods for measuring the relative performance of organizational units or decision-making units [31,77] and may be used to quantify process changes, especially in areas of high-volume care delivery by any member of the team, to assess baseline processes and to propose changes for improving the quality and efficiency of cancer care delivery [34]. Data considered to measure the efficiency gains included qualitative methods like interviews and focus groups, and quantitative methods like surveys, the use of RWD, administrative databases, and big data. As already highlighted by several papers, the panel agrees that RWD and big data, linking different sources of information (administrative databases, registries, clinical data), seems particularly beneficial to provide low-cost benchmark data and practical metrics to support operational efficiency and cost savings [37]; as well as to generate real world evidence (RWE) for oncological care that can better guide treatment decisions and patient-valued care [40] (See Recommendation 5). Only a limited number of studies (around 24 %) analyzed the costs, resource use, and savings connected with efficiency interventions. It is therefore often not possible to quantify the economic effect of reported improvements.

4.3. What are the metrics to evaluate efficiency?

Finally, the third objective of the paper is to identify the metrics used to measure efficiency gains. The literature review and the discussion with the expert panel highlighted that most of the indicators used to measure efficiency gains are process measures (83 % of cases), and relate to the delivery of care (e.g., waiting times, time to perform specific procedures, patient satisfaction) or resource use. This has led to a patchwork of outcome measures and definitions (Table 2) that are not easy to summarize and replicate. An interesting area for future research identified by the expert panel would be the identification of a core outcome set (COS) to evaluate the efficiency improvement for each improvement area identified in this paper (e.g., process management, ISD, HRM) (See Recommendation 6). This would facilitate comparison among different studies and identify major achievements.

Based on the results of the literature review, the expert panel highlighted how the methods and metrics developed so far to evaluate efficiency in cancer care present several strengths but also several weaknesses. It is clear that the use of the observational study is a low-cost design that allows wider application, as well as the use of administrative data and big data allowing for the collection of a large amount of data, constituting a fundamental source of readily available and relatively inexpensive data. However, with the current methods used to evaluate efficiency gains, and without the development of accurate economic evaluation and the collection of outcome measures, it is often difficult to quantify the economic effect of reported initiatives and the outcome of cancer care; and it is not always easy to attribute a causal relationship and/or correlation between technology change, organizational improvements, quality of care, and observed effects, because it is not usually possible to apply case-control design to the evaluative study, and several covariates can have an impact on this. Opportunities to overcome the problem of casual inference can come from the use of big

data over 'small data, as access to more information and evidence can lead to richer descriptive analysis, opening up to new possibilities for exploratory analysis. However, the bottleneck is often the lack of solid research design and theory, both of which are essential to develop, test, and accumulate causal explanation [78]. The expert panel therefore suggests that further studies are needed to share knowledge and find methods to evaluate the impact of change (see Recommendation 7), and, in parallel with this, formulate clear, core indicators for success for each area of improvement identified. It is therefore interesting to develop or extend evaluation methods that can be applied to this area, but that also have a multistakeholder perspective to understand the effects, consequences, and prerequisites that must be achieved for the successful implementation of change. In addition, a more realistic approach of the context, mechanisms, and outcome configuration [79] would facilitate the analysis of results.

4.4. Limitations

The adoption of a scoping literature review method allowed us to include a broader range of studies and design methodologies than systematic reviews [80], however we understand that this could represent a limitation of the study, since we were not able to critically appraise individual studies and evaluate the quality of evidence provided. Like other studies, these results are at risk for bias, which we attempted to minimize using three strategies: 1) defining a broad search strategy; 2) searching not only published literature but also grey literature and websites for relevant and more recent materials and trends; 3) including an expert panel group to identify any missing information.

5. Policy lessons and key recommendations

Our paper offers important insight into the delivery of efficient cancer care. Based on the findings of the literature review and on the opinion of the experts involved in the discussion, and in the NGT, we propose seven recommendations. The first five recommendations are intended to provide insight into how to improve efficiency in cancer care throughout the care pathway, while the last two recommendations aim to improve how to measure efficiency gains. Each recommendation outlines the steps to be taken by key stakeholders (e.g., policymakers, decision-makers, payers, and clinicians) who, at different levels and with diverse areas of responsibility, are involved in the care process and take decisions that can have an impact on cancer care.

5.1. All stakeholders should contribute to improving efficiency in cancer care

Efficiency can be achieved if the entire care pathway is considered from symptom onset, diagnosis, treatment, follow-up, palliation, survivorship, and end of life. This means that improvements in efficiency require the commitment and engagement of all providers [21] to seek areas where the process of care delivery can be improved, and to develop best practice models of care [34]. For each relevant stakeholder Table 3 provides examples of where efficiency could be improved.

5.2. All stakeholders should realize the importance of strengthening cancer networks and of treating patients in certified cancer centers

Managed cancer networks across a national and/or regional territory are widely promoted as an organizational form that enables integrated care as well as enhanced patient outcomes through shared clinical information, standardized clinical pathways, disseminated best practice, and coordinated care [84,85]. The establishment of cancer networks requires combined efforts and actions by several stakeholders listed in Table 4.

Table 3
Stakeholders and actions to be taken to contribute to improve efficiency in cancer care (Recommendation 1).

Stakeholders	Examples of how they can contribute to improve efficiency
Providers and decision-makers	i) Creating the infrastructure (e.g., Electronic health records - EHR), ii) Promoting an environment (i.e. culture, vision) that facilitates the introduction of innovations [61,81], iii) Understanding the perspectives of specialists involved in providing care for cancer patients [61,81] to identify potential waste and inefficient processes; iv) Increasing stakeholder awareness [81]
Policymakers and decision-makers	i) Creating financial incentives (e.g., linking payment to the results achieved or compensating coordination efforts) within the health care systems that foster efficiency [62]; ii) Developing and promulgating policies that clearly define KPIs; iii) Promoting recommendations and care pathways [21,29]; iv) Fostering and incentivizing efficiency by breaking down budget silos or taking cross-silo perspectives spanning the entire health system [82].
Insurers and third-party payers	i) Developing acceptable payment systems to support efficiency improvement [81] ii) Creating incentives to encourage providers to adopt systems that foster efficient care, and new payment models (i.e., bundled payments, payment for coordination, payment for performance) that seek to improve care coordination and align the interests of providers while improving outcomes [83].
Major national organizations (i.e. national cancer institutes, professional organizations, as well as patient organizations)	i) Sponsoring more projects to improve efficiency (e.g., assess multidisciplinary care outcomes, or integrated care pathways - ICPs) ii) Advocating for policies and programs that improve efficiency

5.3. Identify evidence-based practice to improve efficiency in cancer care

Expanding access to high-quality cancer care poses a "value challenge" for many countries. Continuous process improvement should be a goal of all health care stakeholders and shareholders involved.

The panel agrees that best practice, effective cancer control guidelines and evidence-based standards to guide countries in making the right investments towards improving efficiency and outcomes, as well as clear and specific goals and quality standards for improving cancer care, patient outcomes and continuously improving efficiency should be established at international and national level by all relevant stakeholders involved (i.e., policy-makers, professional organizations, national institutes for excellence, patient organizations, etc.). Table 5 provides examples on how several stakeholders can support the identification of evidence-based practice to improve efficiency.

5.4. Identify opportunities, and choose suitable tools and methods to involve patients in designing policies for change

Evidence shows that patient involvement and engagement in healthcare decision-making and policy, and process co-design, empowers patients whilst, at the same time, improving services and health outcomes [75,76]. However, the literature review showed that only a

Table 4
Stakeholder and actions to be taken to strengthen cancer networks (Recommendation 2).

Stakeholders	Examples of actions to strengthen cancer networks
Providers	i) Practice collaborative care (e.g., multiprofessional consultation prior to definitive treatment), work together, refer patients to centers of excellence for specific cancers or specific treatment, and promote access to quality cancer care through innovative technology (e.g., telemedicine where appropriate, virtual tumor board) [22,27,39]
Policy and decision-makers at national and international level	i) Implement clear standards, core input sets (e.g., the E.C.O. Essential Requirements for Quality Cancer Care - ERQCC) and quality frameworks for the certification of cancer centers within the network (e.g. Cancon, iPAAC and OECI certification EUSOMA certification of breast centers), and the effectiveness of the network itself; ii) Emphasize the importance of standards [32] and processes for facilitating communication and knowledge sharing between network members; iii) Oversee harmonization and coordination of best practice (e.g., supporting the definition of a multiprofessional model or the standardization of care pathways) [70]; iv) Support the cancer care workforce in specific efforts to improve efficiency (e.g., via ensuring suitable skill mix, relevant education and training, care coordination, and supporting the wellbeing of the workforce) [82]; v) Promulgate policies to support quality cancer care.
Insurers/payers	i) Financially sustain the development of regional networks in those territories that are still lacking them (e.g., providing funds to employ dedicated roles); ii) Create incentives to encourage providers to adopt systems that facilitate communication and knowledge sharing between network members (e.g., electronic health information systems, collaborative care teams).
Patients and family organizations	i) Advocate for clear standards, quality frameworks, facilitating knowledge exchange (e.g., via websites, communication tools, etc.), ii) Develop tools to help patients and consumers identify cancer programs that embrace evidence-based care and quality improvement.

limited number of studies systematically include the patient perspective. The expert panel agrees that forms of patient involvement should include expressing opinions about different approaches, sharing information, their points of view, and what matters most for them [11,82] but also real experience of co-design and co-creation. At the micro and meso level, the importance of collecting information about the patient experience and outcomes of care through quantitative methods such as surveys, patient-reported outcome measures (PROMs) and patient reported experience measures (PREMs) or qualitative methods like focus groups, interviews, and/or working groups, as well as informal online feedback, are already well known and recognized. However, the time has come to stress the importance of involving patients in designing policy for change. Table 6 provides examples of actions to be taken by several stakeholder.

5.5. Invest in new technology, innovation, and data collection

Recent policy papers have highlighted how innovation in the ways we collect, use, and draw insight from data offer the potential to improve efficiency at every stage of the care pathway [90]. Building efficiency requires cancer care to be delivered via data-driven learning systems [82]. Our work suggests that to maximize the use of data, minimize the burden of data collection, and make such data available, clinical teams and information technology personnel must work together and participate in care redesign and delivery [34,91] to assist in the development of information systems that help data collection and the use of the data collected, as well as to ensure that the new systems capture and report the measures necessary for process improvement [34]. Table 7 provides examples of actions to be taken by different stakeholders to invest in new technology, innovation and data collection.

Table 5
Stakeholders and actions to support the identification of evidence-based practice to improve efficiency in cancer care (Recommendation 3).

Stakeholders	Examples of action to support the identification of evidence-based practice
Policymaker	i) Focus political will [4], encourage change and foster an environment for the execution of evidence-providing studies, by developing and implementing evidence-based policies and standards that prioritize efficiency in cancer care in national health policy.
Providers	i) Adopt evidence-based guidelines and care pathways [30], and advocate for their development through professional organizations; ii) Invest in professional training and life-long learning in medical education
Insurers/payers	i) Define incentives to encourage providers to adopt evidence-based standards.
Patients and families	i) Actively participate in the development of evidence-based practice and facilitate the exchange of best practice. A valuable example is the All.Can Efficiency Hub (https://www.all-can.org/efficiency-hub/), which gathers best-practice examples from around the world, spanning the entire cancer pathway (prevention, screening, diagnosis, treatment and follow-up care, survivorship, and end-of-life care) and showcases the positive impact on efficiency of cancer care.

Table 6
Stakeholders and actions to involve patients in designing policy for change (Recommendation 4).

Stakeholders	Examples of actions to involve patients in designing policy for change
Providers, decision-makers, and policymakers	i) Use the information collected through PROMs, PREMs and qualitative methods to inform the decision-making process; ii) Engage patients and families in the design and/or development of patient-centered processes and systems. iii) Involve patients as members of advisory committees [86,87] iv) Involve patients in the co-design of tools specifically focused on them (e.g., app [88]); v) Involve patients in the design or development of policies; vi) Involve patients in the development and dissemination of tools, information and educational materials [89].

5.6. Agree on minimum core input and outcome sets for care improvement and for making choices by all stakeholders

Outcomes should always be multi-dimensional and include what matters most to patients, not just to clinicians or researchers. The time has come to bring all stakeholders together to agree on minimum core input (CIS) and outcome sets (COS) "standardized" for each important cancer care pathway to facilitate the comparative study, the assessment

Table 7
Stakeholders and actions to invest in new technology, innovation, and data collection (Recommendation 5).

Stakeholders	Examples of actions to invest in new technology, innovation, and data collection
Policymakers	i) Ensure proportionate allocation of funding and investment in the modernization of equipment and hardware to strengthen health information systems and digital tools (e.g., electronic medical records and innovative tools for data analysis and simulation), and to enhance human resources through the development of digital skills of healthcare professionals; ii) Promulgate policies to support the use of new technology and the use of data, and to develop common data standards to improve data safety and quality, representativeness and patient-centered relevance, and to facilitate data interoperability [90].
Insurers/payers	i) Invest in meaningful digital innovations and create incentives to encourage providers to adopt digital innovation (e.g., electronic health information systems).
Patients and their families	i) Provide support to build trust, as well as create public awareness and become involved in education campaigns, to convey the power of meaningful data to better manage cancer care [90].

Table 8
Stakeholders and actions to support the development of minimum core input and outcome sets (Recommendation 6).

Stakeholders	Examples of actions to support the development of CIS and COS
Providers, professional, patients	i) Contribute to the definition of what matters most from a clinical, organizational, and patient perspective; ii) Advocate for the development of evidence-based input / outcome core sets as important tools to identify what works and what does not, or to track any deficiencies in care to their root causes.
Policymakers and decision-makers	i) Support the definition of evidence-based quality-of-care indicators [30] as well as seeking a way to pay for healthcare that aligns all interests, fosters the delivery of superior value to patients, and empowers providers to coordinate and integrate care [65].

of efficiency profile and benchmarking opportunities. Implementing these interventions include many of the tenets of implementation science and the inclusion of all relevant stakeholders [61] (Table 8).

5.7. Develop accurate holistic cost measurement models to optimize value in healthcare

Appropriate measures should include all the processes involved in patient care for a condition, comprehensive data on outcomes, as well as costs across the entire care cycle. Reliable data on costs and outcomes are the starting point for creating a continuous cycle of improvement. Without this data it is impossible to identify value and benefit. However, as highlighted in the review, physicians often lack the tools necessary to rigorously measure and map baseline processes, evaluate proposed changes, and quantify results that can further enhance decision making [34]. Examples from the literature highlight that when applied, data envelopment analysis (DEA) [31,42] or time-driven activity based costing (TDABC) methodologies [34] are really useful economic tools to measure the relative efficiency of health service units and thus project a best possible course of action. Data collection should become a natural part of clinical workflow. All stakeholders should therefore be involved to improve this process (Table 9).

Table 9
Stakeholders and action to be involved to develop accurate holistic cost measurement models (Recommendation 7).

Stakeholders	Examples of actions to develop holistic cost measurement models
Healthcare professionals and providers	i) Involve members of the healthcare team and providers in redesigning the patient care process, allowing for an in-depth examination of healthcare processes and their corresponding costs from within the system [34]; ii) Contribute to the design of real-world data collection systems to avoid additional burden on their workflow
Policymakers	i) Constantly work to define success and set tangible, data-driven models to use existing resources efficiently
HTA bodies	i) Develop accurate holistic cost measurement models to optimize value in healthcare that encompass the cost of the entire cycle of care, by patient and condition.

6. Conclusion

To our knowledge, this is the first attempt to systematize a scattered body of literature on how to improve efficiency in cancer care, to identify key areas to improve efficiency, to provide policy recommendations on how to improve efficiency in cancer care throughout the care pathway, and how to improve the measurement of efficiency gains. Also, using a recent scale developed by Dodd and colleagues for outcome classification [67] we categorized the outcome used to measure efficiency gains according to the core area and outcome domain.

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Conflict of interest

Dr Aapro is, or has been, a consultant for Accord Pharmaceuticals, Amgen, BMS, Celgene, Clinigen Group, Daiichi Sankyo, Eisai Co., Ltd, Eli Lilly, Genomic Health (Exact Sciences), G1 Therapeutics, Inc., GlaxoSmithKline (GSK), Helsinn Healthcare SA, Hospira (Pfizer), Johnson & Johnson, Merck, Merck Serono (Merck KGaA), Mundipharma International Limited, Novartis, Pfizer, Pierre Fabre, Roche, Sandoz, Tesaro (GSK), Teva Pharmaceuticals Industries Ltd., and Vifor Pharma. He has received honoraria for lectures at symposia of Accord Pharmaceuticals, Amgen, Astellas, Bayer HealthCare Pharmaceuticals (Schering), Biocon, Boeringer Ingelheim, Cephalon, Chugai Pharmaceutical Co., Ltd., Daiichi Sankyo, Eisai Co., Ltd., Dr Reddy's Laboratories, Genomic Health (Exact Sciences), Glenmark Pharmaceuticals Limited., GSK, Helsinn Healthcare SA, Hospira (Pfizer), Ipsen, Janssen Biotech, Kyowa Kirin Group, Merck, Merck Serono (Merck KGaA), Mundipharma International Limited, Novartis, Pfizer, Pierre Fabre, Roche, Sandoz, Sanofi, Tesaro (GSK), Taiho Pharmaceutical, Teva Pharmaceutical Industries Ltd., and Vifor Pharma. The other authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jcpo.2022.100355.

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