Health Systems Science Curricula in Undergraduate Medical Education: Identifying and Defining a Potential Curricular Framework

Jed D. Gonzalo, MD, MSc, Michael Dekhtyar, Stephanie R. Starr, MD, Jeffrey Borkan, MD, PhD, Patrick Brunett, MD, Tonya Fancher, MD, MPH, Jennifer Green, MD, MPH, Sara Jo Grethlein, MD, Cindy Lai, MD, Luan Lawson, MD, MAEd, Seetha Monrad, MD, Patricia O’Sullivan, EdD, Mark D. Schwartz, MD, and Susan Skochelak, MD, MPH

Abstract

**Purpose**
The authors performed a review of 30 Accelerating Change in Medical Education full grant submissions and an analysis of the health systems science (HSS)-related curricula at the 11 grant recipient schools to develop a potential comprehensive HSS curricular framework with domains and subcategories.

**Method**
In phase 1, to identify domains, grant submissions were analyzed and coded using constant comparative analysis. In phase 2, a detailed review of all existing and planned syllabi and curriculum documents at the grantee schools was performed, and content in the core curricular domains was coded into subcategories. The lead investigators reviewed and discussed drafts of the categorization scheme, collapsed and combined domains and subcategories, and resolved disagreements via group discussion.

**Results**
Analysis yielded three types of domains: core, cross-cutting, and linking. Core domains included health care structures and processes; health care policy, economics, and management; clinical informatics and health information technology; population and public health; value-based care; and health system improvement. Cross-cutting domains included leadership and change agency; teamwork and interprofessional education; evidence-based medicine and practice; professionalism and ethics; and scholarship. One linking domain was identified: systems thinking.

**Conclusions**
This broad framework aims to build on the traditional definition of systems-based practice and highlight the need for medical and other health professions schools to better align education programs with the anticipated needs of the systems in which students will practice. HSS will require a critical investigation into existing curricula to determine the most efficient methods for integration with the basic and clinical sciences.

Health care delivery in the United States is fragmented, costly, and inefficient.1–5 Faced with increasing accountability for quality of care, patient safety, policy, cost-conscious care, and the need to transform delivery processes, health care systems are transforming practice environments.6 New care delivery models focus increasingly on interprofessional care teams to address the goals of the Institute for Healthcare Improvement’s Triple Aim—to improve the patient experience and population health while reducing costs.7 These changes bring new role expectations for physicians and, therefore, new expectations for medical education programs training the next generation of collaboratively effective, systems-based physicians.8–13

To effectively prepare medical students to thrive in a 21st-century health care system, undergraduate medical education (UME) and graduate medical education (GME) programs must address trainees’ knowledge, attitudes, and skills in systems-based practice (SBP).11,14–19 The medical education community is working to address the transition from UME to GME in this facet of physician development via the Association of American Medical Colleges’ Core Entrustable Professional Activities for Entering Residency (CEPAERs), which include the identification of system failures and contributing to a culture of safety and improvement, and the Accreditation Council for Graduate Medical Education’s (ACGME’s) inclusion of SBP as one of its six core competency domains.20,21 U.S. medical students report inadequate education in health care systems, economics, managed care, and practice management.22,23 Additionally, the literature regarding SBP-related curricula is fragmented and limited despite unified calls for expanded curricula in content areas that are broader than the current ACGME definitions of SBP and practice-based learning (PBL).24 Several independent sources identify critical pieces of this systems-related content, including care transitions, teamwork and coordination, patient safety, policy, cost-conscious care, and public health.6,18,21,24–27

Aligning expanded SBP and PBL content with the CEPAERs and current gaps in curricular content will help define the content of health systems science (HSS).20 Viewed by medical educators as a potential “third science” that complements the basic and clinical sciences, HSS can be considered as the...
methods and principles for improving quality, outcomes, and costs of health care delivery for patients and populations within medical care systems.13 An inclusive HSS curricular framework describing relevant domains does not currently exist in the literature but is necessary to ensure that this critical content does not continue to be marginalized.24 Closing the educational gap noted above requires identifying a clear HSS framework that can lead to the development of educational methods and evaluation measures to ensure that trainees are adequately prepared for medical practice.

In 2013, the American Medical Association solicited grant proposals for their Accelerating Change in Medical Education (ACE) initiative.29 A primary goal for this program was to enhance the systems thinking competencies of medical school graduates. Leveraging the resources of the ACE initiative, we performed a detailed review of 30 full grant submissions and an in-depth analysis of the HSS-related curricula at the 11 ACE grant recipient schools to develop one potential comprehensive HSS curricular framework with domains and subcategories. This report describes the development of a comprehensive HSS curricular framework and its application to build a comprehensive list of curricular content.

**Method**

**Design**

This study was done in two phases: (1) a content analysis of proposed HSS innovations to develop a curricular framework (identifying domains) and (2) an application of the framework to build a list of curricular content (identifying subcategories). We chose this approach because we could not find a source identifying new and cutting-edge topics in HSS and systems thinking applicable to UME or GME. The lead investigators (J.D.G., M.D.) had expertise in designing and implementing an HSS curriculum and/or the research methods used in this work.13,30,31 The University of Illinois at Chicago, the central institutional review board for the ACE initiative, determined that this study did not necessitate oversight because the research activity did not involve human subjects.

**Study setting and approach**

In 2013, the American Medical Association received 30 full grant submissions (preceded by 119 letters of intent) from medical schools, and funded 11 schools as part of the ACE initiative.29 The 11 schools to receive funding were the Warren Alpert Medical School of Brown University; Brody School of Medicine at East Carolina University; University of California, San Francisco, School of Medicine; University of California, Davis, School of Medicine; Indiana University School of Medicine; Mayo Medical School; University of Michigan Medical School; New York University School of Medicine; Oregon Health & Science University School of Medicine; Pennsylvania State University College of Medicine; and Vanderbilt University School of Medicine. These 11 schools formed a consortium in June 2013 to collaborate and share resources and experiences, and most schools proposed new HSS curricular components. The consortium’s HSS interest group launched this study after discussions identified the absence of a comprehensive HSS curricular framework.

To address our research objective and advance understanding of HSS curricular domains and subcategories, we used an inductive content analysis of all 30 full grant submissions to the ACE initiative, as well as all 11 grantees’ syllabi and curriculum documents.32–36 We chose this study design and these data sources, rather than a literature review or interviews with education or systems leaders, because we wanted to identify and synthesize already- or soon-to-be-implemented content applicable to the HSS framework, rather than recommended or conceptualized content.

**Data sources and collection**

We pursued a two-phase approach to this work (see above). In phase 1, we sought to identify a comprehensive list of curricular domains that could be included in an HSS curricular framework. To do this, we planned to analyze all full grant submissions to the ACE initiative (n = 30). Once curricular domains were identified, the lead investigators developed or modified published definitions for each domain (see Table 1).

In phase 2, we sought to identify a comprehensive list of curricular subcategories that could be included in the framework as curricular content. To do this, a site coinvestigator (all authors expect M.D., P.O.’S, S.S.) at each consortium school (n = 11) performed a detailed review of all existing and planned (within one year) syllabi and curriculum documents from all four years of the UME curriculum required of ≥ 75% of students. Using the domains identified and defined in phase 1 as a guide, the lead investigators extracted data applicable to each curriculum domain from the syllabi and curriculum documents (see Supplemental Digital Appendix 1 at http://links.lww.com/ACADMED/A341). Coinvestigators reviewed curricular content with educators at their institution to ensure completeness of data collection and preliminary categorization.

**Conceptual frameworks**

In our approach to the initial data retrieval, coding, and framing of results, we were guided by several conceptual frameworks. For phase 1, George Engel’s biopsychosocial model allowed for the application of a broad-based and holistic empirical lens to identify HSS curriculum areas beyond biomedicine that could potentially be classified in social or systems domains.37,38 The biopsychosocial model draws on systems theory, with a hierarchy spanning the spectrum from subatomic particles to the person (organismic hierarchy), and from the person to the biosphere (social hierarchy).39 We operationalized the biopsychosocial model by excluding content limited solely to biomedicine or physician–patient interactions (i.e., any issue that would relate to a physician and patient interaction). We focused on subsequent strata in the biopsychosocial hierarchy spanning the psychological to systems levels, enabling us to identify a comprehensive HSS curricular framework. For example, curricular content that educated student physicians about how to communicate with patients about weight loss would not have been included in the coding. However, curricular content that sought to educate student physicians about the social factors that influence a patient’s ability to lose weight, such as access to walking paths or their social support structure, would have been coded as population and public health (domain). In phase 2, we further organized the content in each core curricular domain...
### Table 1

**Core, Cross-Cutting, and Linking Domain Definitions for a Health Systems Science (HSS) Curricular Framework**

<table>
<thead>
<tr>
<th>Curricular domain</th>
<th>Working definition for curricular content</th>
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<tbody>
<tr>
<td><strong>Core domains</strong></td>
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<tr>
<td>Health care structures and processes</td>
<td>All issues related to the organization of individuals, institutions, resources, and processes for delivery of health care to meet the needs of patients or populations of patients. This domain includes the processes of collaboration and coordination required for the delivery of health care.</td>
</tr>
<tr>
<td>Health care policy, economics, and management</td>
<td>All issues related to the decisions, plans, and actions undertaken to achieve specific health care goals and the issues related to efficiency, effectiveness, value, and behavior in the production and consumption of health care. These sciences are used to promote health through the study of all components of the health care system and managed care.</td>
</tr>
<tr>
<td>Clinical informatics and health information technology</td>
<td>All issues related to the application of informatics and information technology to deliver health care services, including clinical decision support, documentation, electronic medical records, and the utilization of data to improve health.</td>
</tr>
<tr>
<td>Population and public health</td>
<td>All issues related to traditional public health and preventive medicine, including the full range of health determinants affecting the entire population rather than just those individuals who are sick. Content includes the organized assessment, monitoring, or measurement to prevent disease and injury, promote health, prolong life, or improve any other health outcome for a group of individuals (e.g., geographic populations such as nations, communities, ethnic groups, or any other defined group), including the access to and distribution of such outcomes within the group, and the dynamic interrelationships among various personal, socioeconomic, and environmental factors that relate to health outcomes or prevention.</td>
</tr>
<tr>
<td>Value-based care</td>
<td>All issues related to the performance of a health system as it relates to quality of care delivery, cost, and waste. From the quality perspective, issues relate to the six Institute of Medicine dimensions of quality (patient safety, effectiveness, patient-centeredness, timeliness, effectiveness, and equitability). From the cost perspective, all issues relate to the cost of health care, waste components, and service requirements. The domain includes the epidemiology of, as well as seeing and classifying, gaps in care and care delivery.</td>
</tr>
<tr>
<td>Health system improvement</td>
<td>All issues related to processes of identifying, analyzing, or implementing changes in policy, health care delivery, or any other function of the health care system to improve the performance of any component of the health care system. Issues herein include quantifying and closing gaps (action), variation and measurement (specifically related to quantifying and closing gaps, not to health care measures in general), analysis of data, and interventions.</td>
</tr>
<tr>
<td><strong>Cross-cutting domains</strong></td>
<td></td>
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<tr>
<td>Leadership and change agency</td>
<td>All issues related to the ability to inspire motivation in others to create goals toward a desirable vision. In the context of undergraduate medical education, leadership pertains to team-based care, quality improvement schemes, etc.</td>
</tr>
<tr>
<td>Teamwork and interprofessional education</td>
<td>All issues related to collaboration and team science, specifically through the process of individuals working together on specified tasks to achieved shared goals.</td>
</tr>
<tr>
<td>Evidence-based medicine and practice</td>
<td>All issues related to the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients, populations of patients, or interventions in health care delivery improvement.</td>
</tr>
<tr>
<td>Professionalism and ethics</td>
<td>All issues related to ethical behavior and professionalism, including conduct, congruent with generally accepted moral principles and values and with professional guidelines based on those principles and values. This definition includes general leadership ethics, such as honesty and responsibility, as well as ethics and professionalism specific to the HSS domains.</td>
</tr>
<tr>
<td>Scholarship</td>
<td>All issues related to scholarship of HSS content and/or health services research that investigates any HSS domain. Scholarship is defined as (1) discovery, which is consistent with traditional research; (2) integration, which makes connections across disciplines and places specialties in a larger context; (3) application, which demonstrates the vital interaction between research and practice; and (4) teaching (educational scholarship), which emphasizes the creation of new knowledge about teaching and learning in the presence of learners.</td>
</tr>
<tr>
<td><strong>Linking domain</strong></td>
<td></td>
</tr>
<tr>
<td>Systems thinking</td>
<td>All issues related to the attention of a complex web of interdependencies, an awareness of the &quot;whole,&quot; not just of the parts, and the ability to recognize multidirectional cause–effect relationships with all causes emerging as the effect of another system dynamic.</td>
</tr>
</tbody>
</table>

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Citations listed after each domain refer to the references from which the authors modified definitions for the purposes of this work.

Core curricular domains are content areas that align directly with HSS.

Cross-cutting domains refer to content areas that may have been traditionally included in an undergraduate medical education curriculum, but in this analysis, these domains were emphasized within the context of the HSS.

The linking domain refers to content that unifies or links the core curricular or cross-cutting domains to other core curricular or cross-cutting domains (internal linking) and to other areas of the curriculum, such as the basic and clinical sciences (external linking).

Using existing frameworks from the literature that were the most appropriate for the content items retrieved (e.g., in the example above, the subcategory would have been determinants of health).

Co-investigators collaboratively reviewed content, discussed potential coding schemes, and resolved disagreements via group discussion during workgroup phone calls.

Data analysis

For phase 1, the lead investigators used constant comparative analyses to jointly code 2 full grant submissions and generate a preliminary codebook.

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to facilitate analysis. Codes reflected the domains of curricular content, as shown in Table 1. Investigators then analyzed subsequent full grant submissions, with regular adjudication sessions to compare codes for inconsistency and agreement, and updated and modified the codebook. On the basis of the initial codebook and regular discussions, data saturation was reached after 12 grant submissions. However, a total of 15 submissions were coded to ensure saturation.

We used the results from phase 1 to create a framework to use in phase 2; although some specific curricular content within each domain was identified in phase 1, the majority of these initial data were not specific enough to identify subcategories or specific topic areas. With data obtained from each school’s detailed curricular review in phase 2, and informed by applicable frameworks, the lead investigators coded content in the core curricular domains into subcategories in collaboration with co-investigators. All investigators contributing to content categorization within each core curricular domain were actively practicing physicians and/or educators with interest in particular curricular domains and, therefore, had a working knowledge of HSS.

Analysis was performed with data management support from the programs ATLAS.ti 6.0 (Scientific Software Development GmbH, Berlin, Germany) and NVivo 10 (QSR International Pty Ltd., Burlington, Massachusetts). The lead investigators reviewed and discussed selected drafts of the categorization scheme, collapsed and combined domains and subcategories, and resolved disagreements via group discussion during workgroup phone calls. We conducted member checking, a technique used to support the validity of content analysis, via telephone calls with the larger research team, which consisted of educators, administrators, and evaluators at the 11 grantee schools.

Results

Our analysis yielded three types of curricular domains: (1) core, (2) cross-cutting, and (3) linking (see Table 1). Figure 1 illustrates the relationship between these three types of domains. Subcategories (and subtopics) for the core curricular domains are organized using previously published conceptual frameworks (Table 2). Content representative of each domain is shown in Tables 2 (core domains) and 3 (cross-cutting and linking domains).

Core curricular domains are content areas that align directly with HSS. These six domains include health care structures and processes; health care policy, economics, and management; clinical informatics and health information technology; population and public health; value-based care; and health system improvement. Content was clustered into a cross-cutting domain if it was identified as transcending multiple core curricular domains. Many UME curricula traditionally address many of these domains, but in this analysis, these domains were emphasized within the context of HSS. These five domains include leadership and change agency; teamwork and interprofessional education; evidence-based medicine and practice; professionalism and ethics; and scholarship. Finally, content that unifies or links the core curricular or cross-cutting domains to other core curricular or cross-cutting domains (internal linking) and to other areas of the curriculum, such as the basic and clinical sciences (external linking), was assigned to the single linking domain: systems thinking. The content of systems thinking allows students to be cognizant of and apply a comprehensive holistic approach to medical care and health care issues. For example, systems thinking skills allow a student to understand the influence of the Affordable Care Act on the determinants of health within a community, and as a result, the ability for his/her patient to access health care and adhere to care plans.

Discussion

Educators have previously proposed a new paradigm for UME that augments the traditional basic and clinical sciences to include a triad of sciences—basic, clinical, and HSS. The ACGME defines SBP as “an awareness of and responsiveness to the larger … system of health care” and “the ability to call effectively on other resources in the system to provide optimal health care.” In this context, resident physicians are expected to function in various health care delivery settings, incorporate cost awareness into their decision making, advocate for optimal care systems, and work in interprofessional teams to improve patient care quality. The proposed new UME paradigm requires an evolution of our understanding of the SBP competency and an evaluation framework, which we described in this report as a comprehensive HSS curricular framework.

Our analysis supports that UME educators have implemented or are implementing
<table>
<thead>
<tr>
<th>Core curricular domains (conceptual frameworks for coding)</th>
<th>Subcategories (and subtopics) within the core curricular domains</th>
<th>Representative curricular content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health care structures and processes (Donabedian⁶⁴ and McDonald et al⁶⁵)</td>
<td>• Health systems principles and concepts&lt;br&gt;• Health care structures&lt;br&gt;  ○ Health care structure and resources&lt;br&gt;  ○ Health care provider roles&lt;br&gt;• Health care processes&lt;br&gt;  ○ Transitions of care&lt;br&gt;  ○ Care coordination and collaboration&lt;br&gt;  ○ Insufficiencies in system</td>
<td>• Knowledge of clinical microsystems and processes occurring within outpatient and inpatient settings.&lt;br&gt;• Fragmentation and insufficiencies encountered by patients in the health care continuum.&lt;br&gt;• Identify the importance of teamwork within clinical “teams” and “communities” that span diverse settings.</td>
</tr>
<tr>
<td>Health care policy, economics, and management (not applicable)</td>
<td>• Policy&lt;br&gt;• Health care reform&lt;br&gt;• Health care economics&lt;br&gt;  ○ Insurance&lt;br&gt;  ○ Management</td>
<td>• History and core principles of health care policy.&lt;br&gt;• Basics of how health care is financed and the impact of health care policy on insurance and reimbursement.&lt;br&gt;• Incentives for providers and hospitals within different U.S. payment models.</td>
</tr>
<tr>
<td>Clinical informatics and health information technology (Hersh et al⁴⁰ and Otero et al⁴¹)</td>
<td>• Informatics/technology&lt;br&gt;• Clinical data&lt;br&gt;  ○ Physician–patient level&lt;br&gt;  ○ System level&lt;br&gt;  ○ Research/quality improvement&lt;br&gt;• Electronic health records&lt;br&gt;• Health information exchange</td>
<td>• Core principles of informatics sciences, including biomedical informatics, patient security, and rights protection with regard to data.&lt;br&gt;• Awareness of real-time data viewing and decision support to manage data registries and analyze clinical reports.&lt;br&gt;• Awareness of current functionality and challenges in current health information exchange.</td>
</tr>
<tr>
<td>Population and public health (Public Health Foundation,⁴⁶,⁴⁷ World Health Organization,⁶⁶ Diez Roux,⁵⁸ Young,⁶⁸ Glass and McAtee,⁶⁶ and Kilbourne et al⁶⁹)</td>
<td>• Public health&lt;br&gt;• Population health management&lt;br&gt;• Health care disparities/vulnerable patient populations&lt;br&gt;• Provider factors&lt;br&gt;• Determinants of health&lt;br&gt;  ○ Social and economic factors&lt;br&gt;  ○ Physical environment&lt;br&gt;  ○ Person’s individual characteristics and behaviors</td>
<td>• Ability to build a community asset map to identify local resources that can help address a leading health indicator.&lt;br&gt;• Define patient risk behaviors within the context of health determinants in uninsured populations.&lt;br&gt;• Develop cultural skills to work with individuals from diverse cultural backgrounds.</td>
</tr>
<tr>
<td>Value-based care (Institute of Medicine Committee on Quality of Health Care in America⁷¹ and Porter⁷⁰)</td>
<td>• Value&lt;br&gt;  ○ Measurement&lt;br&gt;  ○ Cost&lt;br&gt;• Quality (encompassing all Institute of Medicine aims⁸⁴)&lt;br&gt;  ○ Patient safety&lt;br&gt;  ○ Effectiveness&lt;br&gt;  ○ Patient-centered care</td>
<td>• Principles of value-based care, including quality and cost.&lt;br&gt;• Key correlations between quality and safety principles with patient outcomes.&lt;br&gt;• Recognize the importance of identifying and reporting safety events.</td>
</tr>
<tr>
<td>Health system improvement (Grabari⁷²)</td>
<td>• Root cause analysis&lt;br&gt;• Quality improvement tools, methods, and principles&lt;br&gt;• Quality improvement skills and projects&lt;br&gt;• Change management</td>
<td>• Select a quality indicator and develop an improvement plan.&lt;br&gt;• Draft a plan–do–study–act worksheet that outlines a test of change.&lt;br&gt;• Ability to adapt to different improvement challenges with different evidence-based methodologies.</td>
</tr>
</tbody>
</table>

*Core curricular domains are content areas that align directly with health systems science. References listed after each domain are the conceptual frameworks the authors used in phase 2 of the analysis to categorize curricular content into subcategories.

See Table 1.
Cross-cutting and Linking Domains With Representative Curricular Content for a Health Systems Science Curricular Framework

<table>
<thead>
<tr>
<th>Domain</th>
<th>Representative curricular content</th>
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<tbody>
<tr>
<td><strong>Cross-cutting domains</strong></td>
<td></td>
</tr>
<tr>
<td>Leadership and change agency</td>
<td>• Recognize types of leadership in health care and key competencies required for each type; identify key skills physicians must develop to become true leaders.</td>
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<td></td>
<td>• Reflect on personal values and synchrony with life goals; understand how successful leaders have alignment between personal and institutional values.</td>
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<tr>
<td></td>
<td>• Recognize it is within your power to suggest and implement changes in the health care systems in which you work.</td>
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<tr>
<td>Teamwork and interprofessional education</td>
<td>• Knowledge and awareness of interprofessional providers’ roles and skills.</td>
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<td></td>
<td>• Communication required to function in teams in an integrated and coordinated system.</td>
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<tr>
<td></td>
<td>• Skills to function effectively in a team and apply reflective practice in the context of quality improvement and patient safety.</td>
</tr>
<tr>
<td>Evidence-based medicine and practice</td>
<td>• Appropriate use of decision support tools in decision-making processes within a virtual health system environment.</td>
</tr>
<tr>
<td></td>
<td>• Utilize evidence-based guidelines and bundled protocols to ensure appropriate care delivery for patient panels.</td>
</tr>
<tr>
<td></td>
<td>• Epidemiology and biostatistical methods required to understand gaps in care and disparities for populations of patients.</td>
</tr>
<tr>
<td>Professionalism and ethics</td>
<td>• Define professionalism and its relations to trust and improving value in health care; understand the importance of professionalism for success as a leader.</td>
</tr>
<tr>
<td></td>
<td>• Professionalism involved with collaborative team-based models of care.</td>
</tr>
<tr>
<td></td>
<td>• Awareness of professionalism in the context of social media.</td>
</tr>
<tr>
<td>Scholarship</td>
<td>• Development, completion, and presentation of scholarly projects in a quality and patient safety symposium.</td>
</tr>
<tr>
<td></td>
<td>• Opportunities for population-based research projects.</td>
</tr>
<tr>
<td></td>
<td>• Advanced expertise through advanced application of knowledge and skills in interprofessional team-based care, quality improvement, leadership, and change management, as demonstrated through scholarly projects.</td>
</tr>
<tr>
<td><strong>Linking domain</strong></td>
<td></td>
</tr>
<tr>
<td>Systems thinking</td>
<td>• Demonstrate an awareness of the larger social and economic context in which health systems exist.</td>
</tr>
<tr>
<td></td>
<td>• Describe features of the environment (i.e., multitasking, distractions, etc.) which increase the risk of cognitive errors, and suggest several strategies for dealing with these factors.</td>
</tr>
<tr>
<td></td>
<td>• Recognition of the need to be proactive and have a clear vision of the consequences resulting from not taking certain steps in care delivery.</td>
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</tbody>
</table>

*Cross-cutting domains refers to content areas that may have been traditionally included in an undergraduate medical education curriculum, but in this analysis, these domains were emphasized within the context of health systems science.

*The linking domain refers to content that unifies or links the core curricular or cross-cutting domains to other core curricular or cross-cutting domains (internal linking) and to other areas of the curriculum, such as the basic and clinical sciences (external linking).

HSS curricula for a majority of their students that are broader in scope than the ACGME definition of SBP, and contain pertinent topic areas addressed in the CEPAERs. The domains, working definitions for curricular content, conceptual frameworks, and subcategories (and subtopics) reported here are a starting point for the development of HSS competencies and entrustable professional activities.

Several studies highlight existing and potential HSS topics or concepts that should be considered in such a framework. These include patient safety, coordination of care, multidisciplinary teams, cost awareness, quality improvement, practice management, medical record keeping, managed care, health care systems, and medical economics. Others allude to the implementation of health-care-related sciences, including global and public health and the skills required for 21st-century providers, such as interprofessional collaboration, quality improvement, clinical informatics, and social medicine. Our studies synthesize these topics and concepts into one comprehensive HSS curricular framework and lay the groundwork for a critical review of current curricula, program design, and instructional methods, as well as programmatic development and assessment by medical education programs.

We identified several cross-cutting domains of knowledge and skills that traditionally may have been included in UME programs but have a new emphasis in this HSS curricular framework. These cross-cutting domains highlight the overlap and application of the proposed HSS domains with traditional areas of the curriculum. For example, leadership and change agency skills may have been included in some traditional UME programs. In our analysis, though, leadership and change agency knowledge and skills were specifically focused on health systems improvement projects or learner roles on interprofessional care teams. With the transformation into an expanded content and competencies set required for the HSS curricular framework, cross-cutting domains require UME programs to reevaluate their curriculum and assess areas in need of updating or modification. Curricula related to leadership and change agency, professionalism and ethics, and evidence-based medicine and practice, for example, may require modification to better contextualize these areas for 21st-century health systems education, even for schools that do not plan to have a comprehensive HSS curriculum.

Although they have previously been proposed as a component of public health competencies, explicit systems thinking skills appear to be new to UME. The proposed skill set of systems thinking is a critical piece to include in curricula because it reflects the evolving landscape of health systems toward learning organizations, where the health system and providers become more interconnected and continuously transform systems to improve outcomes.

The potential HSS curricular framework reported here is built from a practical perspective and reflects curricular topics...
that are currently or will soon be required content for most students taught in UME programs (i.e., it does not reflect recommendations alone). Additionally, this broad conceptualization of HSS reframes the view of educating future physicians. Although our results originate from U.S. UME programs, we believe this HSS curricular framework and content are applicable to GME and continuing medical education, as well as to many allied health professions educational programs, in the United States and abroad. Like many medical schools, other health professional programs, including nursing, pharmacy, and physician assistant programs, are incorporating HSS topics into their curricula. Several authorities (e.g., the Interprofessional Education Collaborative and CanMEDS) increasingly emphasize interprofessional competencies, specifically in quality improvement and patient safety.5,2,12 In addition, health care transformation to achieve the Triple Aim applies to all educational programs fostering the development of future team members in these care delivery models.7 Our results have the potential to provide an HSS curricular framework for all health professions programs.

We believe this work informs potential next steps related to the HSS. First, these results can and should be used in subsequent work to develop educational methods and evaluation measures (e.g., milestones, competencies, entrustable professional activities) and to design and implement curricula that enable undergraduate trainees to be effective health care professionals. Second, future work should assess these domains for their prevalence and perceived importance in educational programs, the practicality of applying them in interprofessional contexts, and their alignment with the needs of the health system. Specifically, our results provide a static, two-dimensional perspective of the HSS curriculum, but it would be important to present the right educational intervention at the relevant time and in the relevant setting. The continuum between UME, GME, and continuing medical education programs requires a clear road map of trainee progression, specifically in these areas. Future work will be needed to determine when and where along the training spectrum these topics should be introduced. For example, a curriculum inventory mapping tool, such as the Tool for Assessing Cultural Competence Training, could be developed and applied across the educational continuum to assess and target the incorporation of HSS in individual medical education programs.3,5

There are several limitations to this work. First, although curriculum design ideally starts with learner outcomes rather than content, given the lack of consensus-driven HSS learner outcomes in the literature, we believe the identification of a potential comprehensive curricular framework with domains and subcategories was a required first step to inform the development of learner outcomes.3,2,12 We considered existing resources (e.g., the Association of American Medical Colleges’ entrustable professional activities and the ACGME’s core requirements), but none adequately provided a comprehensive framework and assembly of content for HSS.2,2,12 Until medical school accreditation is based on more detailed content requirements, UME educators seek a broad menu of curricular items that are grounded in UME experience. We additionally acknowledge that a comprehensive list of curricular topics is less useful than a consensus-driven list of minimum UME learner outcomes; many of the consortium schools are concurrently working toward this goal, informed in part by these results. Next, individual school assessments were limited to the 11 consortium schools (a group of schools seeking to innovate in these areas) rather than a larger sample of schools; although including more schools in the assessments might have captured new curricular content, we found considerable overlap within these 11 schools. We reached data saturation before the completion of phase 1, and this intensive and resource-laden investigation at each consortium school provided a depth that would not have been achievable through a broader or more remote data collection. We considered alternative study designs, such as a Delphi process, whereby experts in education and the health systems would contribute their views about curricular content that needed to be required in a UME program. Therefore, our results have some shortcomings in that the curricular content may not represent a fully exhaustive curricular framework. We also recognize that there is significant conceptual overlap across the core curricular domains (e.g., value-based care and health system improvement) and subcategories within domains (e.g., health care disparities/vulnerable patient populations and determinants of health) and that consensus building by other authors may have yielded different results. Despite these limitations, we believe the method and results are a critical call to action for the medical education community and contribute to potential subsequent work dedicated to elaborating on this initial HSS framework.

In conclusion, we leveraged the work of the ACE initiative to identify six core domains with subcategories (and subtopics), five cross-cutting domains, and one linking domain for an HSS curriculum. This broad framework aims to build on the traditional definition of SBP to better address the needs for 21st-century physician training and to highlight the need for medical and other health professions schools to better align education programs with the anticipated needs of the health care delivery systems in which students will practice. This framework can catalyze the national conversation regarding the knowledge and skills required for physician trainees to become collaboratively effective, systems-based physicians. This third science—HSS—will require a critical investigation into existing curricula to determine the most efficient methods for integration with the basic and clinical sciences. Future work should explore comprehensive learning objectives; identify ideal educational methodologies, such as authentic experiential learning opportunities, for engaging in HSS content; and provide curricular examples that emphasize active learning. In addition, we advocate for the development of valid assessments that test student outcomes, along with robust investigations of the value added to the health system through the incorporation of HSS. Though the conceptualization of HSS curricular domains is just at the beginning, these efforts have the potential to affect medical education for decades to come.

Funding/Support: This project was performed with financial support from the American Medical Association as part of the Accelerating Change in Medical Education Initiative.

Other disclosures: T. Fancher is also funded by the Health Resources & Services Administration. To our knowledge, no conflict of interest, financial or other, exists for any author. The views expressed in this paper reflect the views of the authors and do not necessarily represent the views of the American Medical Association or other participants in this initiative.
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