REPORTS OF THE COUNCIL ON LONG RANGE PLANNING AND DEVELOPMENT

The following reports were presented by Edmund Cabbabe, MD, Chair:

1. DEMOGRAPHIC CHARACTERISTICS OF THE HOUSE OF DELEGATES AND AMA LEADERSHIP

Informational report; no reference committee hearing.

HOUSE ACTION: FILED

This informational report is prepared in odd numbered years by the Council on Long Range Planning and Development (CLRPD), pursuant to American Medical Association (AMA) Policy G-600.035, "The Demographics of the House of Delegates." This policy states:

> (1) A report on the demographics of our AMA House of Delegates will be issued annually and include information regarding age, gender, race/ethnicity, education, life stage, present employment, and self-designated specialty. (2) As one means of encouraging greater awareness and responsiveness to diversity, our AMA will prepare and distribute a state-by-state demographic analysis of the House of Delegates, with comparisons to the physician population and to our AMA physician membership every other year. (3) Future reports on the demographic characteristics of the House of Delegates should, whenever possible, identify and include information on successful initiatives and best practices to promote diversity within state and specialty society delegations.

This report will survey the current demographic makeup of AMA leadership in accordance with AMA Policy G-600.030, "Diversity of AMA Delegations," which states that, "Our AMA encourages…state medical associations and national medical specialty societies to review the composition of their AMA delegations with regard to enhancing diversity..." and AMA Policy G 610.010, "Nominations," which states in part:

> Guidelines for nominations for AMA elected offices include the following... (2) the Federation (in nominating or sponsoring candidates for leadership positions), the House of Delegates (in electing Council and Board members), and the Board, the Speakers, and the President (in appointing or nominating physicians for service on AMA Councils or in other leadership positions) to consider the need to enhance and promote diversity…

Like previous reports, this document compares AMA leadership with the entire AMA membership and with the overall U.S. physician population. Medical students are included in all references to the total physician population, which is consistent with past practice. For the purposes of this report, AMA leadership includes delegates; alternate delegates; the Board of Trustees (BOT); and councils and leadership of sections and special groups (hereafter referred to as CSSG; see detailed listing in Appendix A).

Additionally, this report includes information on successful initiatives and best practices to promote diversity of state and specialty society delegations, pursuant to part 3 of Policy G-600.035.

DATA SOURCES

Lists of delegates and alternate delegates are maintained by the Office of House of Delegates (HOD) Affairs and based on official rosters provided by the relevant societies. The lists used in this report reflect year-end 2022 delegation rosters. AMA council rosters as well as listings for the governing bodies of each of the sections and special groups were provided by the relevant AMA staff.

Data on demographic characteristics of individuals are taken from the AMA Physician Masterfile, which provides comprehensive demographic, medical education, and other information on all graduates of U.S. medical schools and international medical graduates (IMGs) who have undertaken residency training in the United States. Data on AMA members and the total physician population are taken from the year-end 2022 Masterfile after it is considered final.

Some key considerations must be kept in mind regarding the information in this report. Members of the BOT, the American Medical Political Action Committee (AMPAC) and the Council on Legislation who are not physicians or medical students are not included in any tables. Vacancies in delegation rosters mean the total number of delegates is fewer than the number allotted at the 2022 Interim Meeting, and the number of alternate delegates is nearly always less than the full allotment. Race and ethnicity information, which is provided directly by physicians, is missing for approximately one-fifth of AMA members (20.0%) and the total U.S. physician population (20.4%), limiting the ability to draw firm conclusions.

Readers are reminded that most AMA leadership groups considered herein designate seats for students and resident/fellow physicians. This affects some characteristics, particularly age, as well as the makeup of age-related groups, namely the student, resident, and young physician sections. To provide further clarity on this point, an additional table has been included in the appendix illustrating demographic characteristics and career stage breakdowns of AMA section governing councils.

CHARACTERISTICS OF AMA LEADERSHIP

Table 1 displays the basic characteristics of AMA leadership, AMA members, and all physicians and medical students. Raw counts for Tables 1 and 2 can be found in Appendix A. Upward- and downward-pointing arrows indicate an increase or decrease of at least two percentage points compared to CLRPD Report 1-A-21, “Demographic Characteristics of the House of Delegates and AMA Leadership”; the following observations refer to changes since CLRPD Report 1-A-21. Changes are not highlighted for the BOT due to the small number of Board members. Between year-end 2020 and year-end 2022, AMA membership increased by 3,061 members, a 1.1% increase.

- Little change was observed in the age breakdown of AMA membership and leadership. The share of delegates in the 60-69 age group decreased by 3.9 percentage points since 2020, but no age group saw a significant increase. Likewise, among councils and leadership of sections and special groups, two age groups (under age 40 and age 50-59) saw increased representation, while two others (40-49 and 60-69) saw their percentages decrease, but these changes seem more attributable to fluctuation than any specific trend.

- A continued increase in female representation among AMA delegates and alternate delegates was observed, as females in 2022 made up 34.3% of delegates (up from 30.7% in 2020) and 43.7% of alternate delegates (38.3% in 2020). Over the past decade, the number of female delegates and alternate delegates has increased steadily; in 2012, 20.2% of delegates and 21.5% of alternate delegates identified as female.

- The percentage of white delegates and alternate delegates decreased by 3.5 percentage points and 4.4 percentage points, respectively.

- The percentage of international medical graduate (IMG) alternate delegates increased by 2.7 percentage points.

Table 1. Demographic Characteristics of AMA Leadership, December 2022

	Delegates[1]	Alternate Delegates[2]	Board of Trustees[2]	Councils and Leadership of Sections and Special Groups[3]	AMA Members	All Physicians and Medical Students
Count	661	391	20	167	274,716	1,455,177
Mean age[4]	56.7	50.1	54.4	51.1	47.1	52.9
Age Distribution						
Under age 40	15.4%	30.4%	10.0%	30.5%↑	51.4%	29.4%
40-49 years	15.0%	17.7%	20.0%	13.8%↓	11.2%	17.6%
50-59 years	20.0%	19.7%	30.0%	21.6%↑	9.8%	16.4%
60-69 years	28.3%↓	22.3%	30.0%	19.2%↓	9.6%	16.2%
70 or more	21.3%	10.0%	10.0%	15.0%	18.0%	20.4%
Gender						
Male	65.7%↓	55.8%↓	60.0%	50.9%	60.0%	62.7%
Female	34.3%↑	43.7%↑	40.0%	49.1%	39.5%	36.6%
Unknown	0.0%	0.5%	0.0%	0.0%	0.6%	0.8%
Race/Ethnicity						
White non-Hispanic	65.8%↓	57.3%↓	45.0%	56.9%	48.9%	49.7%
Black non-Hispanic	5.5%	4.9%	15.0%	6.6%	4.9%	4.3%
Hispanic	3.0%	4.4%	5.0%	3.0%	4.5%	4.6%
Asian/Asian American	12.7%	15.9%	20.0%	18.6%	15.4%	15.8%
Native American	0.3%	0.3%	0.0%	0.0%	0.2%	0.2%
Other[5]	2.6%	5.9%↑	0.0%	7.2%↑	6.2%↑	5.0%↑
Unknown	10.1%	11.5%	15.0%	7.8%	20.0%	20.4%
Education						
US or Canada	92.1%	89.5%↓	100.0%	88.0%	81.9%	77.7%
IMG	7.9%	10.5%↑	0.0%	12.0%	18.1%	22.3%

[1] Numbers include medical students and residents endorsed by their states for delegate and alternate delegate positions.
[2] Numbers do not include the public member of the Board of Trustees, who is not a physician.
[3] Numbers do not include non-physicians on the Council on Legislation and the American Medical Political Action Committee. In addition, Appendix A contains a listing of the AMA Councils, Sections, and Special Groups.
[4] Age as of December 31. Mean age is the arithmetic average.
[5] Includes other self-reported racial and ethnic groups.

Table 2 displays life stage, present employment, and self-designated specialty of AMA leadership.

- No significant changes were observed to the life stage, employment, and specialty characteristics of delegates to the HOD. Among alternate delegates, decreases were observed among established physicians (from 49.7% in 2020 to 44.0% in 2022), employees of the U.S. government (4.1% in 2020, 2.1% in 2022) and internal medicine specialists (19.2% in 2020, 15.1% in 2022). The percentage of senior physician alternate delegates increased from 19.4% to 22.5% since 2020.

- Among CSSG, increases were observed among young physicians (9.6% in 2020, 13.2% in 2022), employees of non-government hospitals (4.2% in 2020, 6.6% in 2022) and internal medicine specialists (18.7% in 2020, 22.2% in 2022). Decreases were observed among senior physicians (28.9% in 2020, 24.6% in 2022), employees of state or local government hospitals (10.8% in 2020, 7.2% in 2022) and OB/GYN specialists (13.3% in 2020, 9.6% in 2022).

Table 2. Life Stage, Present Employment and Self-Designated Specialty of AMA Leadership, December 2022

	Delegates	Alternate Delegates	Board of Trustees	Councils and Leadership of Sections and Special Groups	AMA Members	All Physicians and Medical Students
Count	661	391	20	167	274,716	1,455,177
Life Stage						
Student[6]	4.8%	10.5%	5.0%	9.6%	19.5%	8.0%
Resident[6]	5.8%	8.7%	5.0%	11.4%	26.2%	10.1%
Young (Under age 40 or first eight years of practice) ^	7.4%	14.3%	0.0%	13.2%↑	9.9%	15.4%
Established (Age 40-64) ^	45.1%	44.0%↓	65.0%	41.3%	21.7%	37.9%
Senior (Age 65 or more)^	36.9%	22.5%↑	25.0%	24.6%↓	22.8%	28.6%
Present Employment						
Self-employed solo practice	12.1%	8.4%	15.0%	10.8%	6.2%	7.6%
Two physician practice	1.7%	2.1%	5.0%	1.2%	1.3%	1.8%
Group practice	39.8%	38.6%	45.0%	34.7%	24.0%	39.7%
Non-government hospital	7.7%	7.2%	10.0%	6.6%↑	3.0%	4.1%
State or local government hospital	10.3%	9.7%	5.0%	7.2%↓	3.6%	6.0%
HMO	1.1%	0.5%	0.0%	1.2%	0.2%	0.2%
Medical School	3.9%	2.8%	10.0%	3.6%	0.9%	1.4%
U.S. Government	3.0%	2.1%↓	0.0%	3.6%	0.8%	1.6%
Locum Tenens	0.3%	0.3%	0.0%	1.2%	0.1%	0.2%

[6] Students and residents are so categorized without regard to age.
^ Reflects section/group definition of its membership.

Retired/Inactive	7.7%	4.6%	0.0%	6.6%	11.4%	12.6%
Resident/Intern/ Fellow	5.8%	8.7%	5.0%	11.4%	26.2%	10.1%
Student	4.8%	10.5%	5.0%	9.6%	19.5%	8.0%
Other/Unknown	1.8%	4.6%	0.0%	2.4%	2.7%	7.0%
Self-designated specialty[7]						
Family Medicine	11.0%	11.0%	5.0%	10.8%	8.8%	11.3%
Internal Medicine	21.8%	15.1%↓	20.0%	22.2%↑	20.6%	22.8%
Surgery	22.1%	17.4%	30.0%	15.6%	13.4%	13.3%
Pediatrics	3.5%	5.4%	0.0%	7.2%	5.3%	8.7%
OB/GYN	5.9%	7.9%	15.0%	9.6%↓	4.9%	4.5%
Radiology	5.8%	5.1%	5.0%	2.4%	3.6%	4.4%
Psychiatry	3.8%	5.6%	0.0%	4.8%	4.4%	5.2%
Anesthesiology	3.8%	3.1%	5.0%	2.4%	3.9%	4.9%
Pathology	2.0%	3.8%	0.0%	0.0%	1.7%	2.2%
Other specialty	15.6%	15.1%	15.0%	15.6%	13.9%	14.7%
Student	4.8%	10.5%	5.0%	9.6%	19.5%	8.0%

For further data, including information on state medical associations and national medical specialty societies, raw counts of the above tables, and detailed state and specialty society data, please see the appendices.

PROMOTING DIVERSITY AMONG DELEGATIONS

Pursuant to Part 3 of AMA Policy G-600.035, CLRPD queried state and specialty societies on initiatives they have instituted to encourage diversity among their delegations, and the outcomes of these initiatives.

- Convening groups with a focus on diversity: several societies mentioned convening task forces, councils and/or committees with the goal of evaluating and/or increasing diversity among their organization, including their delegations and other leadership positions. Societies that have implemented these types of groups reported a number of beneficial outcomes including advising the society on internal and external action, developing educational programming and online content, writing grants, and increasing diversity at society meetings.

- Intentional recruitment: societies mentioned making a conscious effort to recruit diverse candidates from across their organizations and ready them for larger leadership opportunities. Additionally, some societies reported making conscious outreach efforts to medical students, including those from historically black colleges and universities, with the goal of increasing diversity within their respective societies, and in the case of specialties, among the specialty itself.

- Initiatives and summits: societies mentioned instituting a variety of initiatives focused on issues related to equity, diversity, and inclusion. These included convening members with interest in addressing lifestyle-related chronic disease health disparities, training and certification scholarships for physicians who are representative of and delivering care to underserved communities, leadership summits to prepare young members for future leadership roles, and podcasts to discuss issues related to health and wellness through a DEI lens.

APPENDIX A

Table 3. Demographic Characteristics of AMA Leadership, December 2022

[7] See Appendix B for a listing of specialty classifications.

	Delegates[2]	Alternate Delegates[2]	Board of Trustees[3]	Councils and Leadership of Sections and Special Groups[4]	AMA Members	All Physicians and Medical Students
Mean age[5]	56.7	50.1	54.4	51.1	47.1	52.9
Count	661	391	20	167	274,716	1,455,177
Age distribution						
Under age 40	102	119	2	51	141,319	428,442
40-49 years	99	69	4	23	30,766	255,897
50-59 years	132	77	6	36	26,892	238,054
60-69 years	187	87	6	32	26,436	236,073
70 or more	141	39	2	25	49,303	296,711
Gender						
Male	434	218	12	85	164,789	911,708
Female	227	171	8	82	108,362	532,338
Unknown	-	2	-	-	1,565	11,131
Race/ethnicity						
White non-Hispanic	435	224	9	95	134,244	723,379
Black non-Hispanic	36	19	3	11	13,379	63,150
Hispanic	20	17	1	5	12,234	67,553
Asian/Asian American	84	62	4	31	42,310	229,363
Native American	2	1	-	-	470	2,546
Other[6]	17	23	-	12	17,096	72,773
Unknown	67	45	3	13	54,983	296,413
Education						
US or Canada	609	350	20	147	224,961	1,130,279
IMG	52	41	0	20	49,755	324,898

[2] Numbers include medical students and residents endorsed by their states for delegate and alternate delegate positions.
[3]Numbers do not include the public member of the Board of Trustees, who is not a physician.
[4]Numbers do not include non-physicians on the Council on Legislation and the American Medical Political Action Committee. In addition, Appendix A contains a listing of the AMA Councils, Sections, and Special Groups.
[5] Age as of December 31. Mean age is the arithmetic average.
[6] Includes other self-reported racial and ethnic groups.

Table 4. Life Stage, Present Employment and Self-Designated Specialty[1] of AMA Leadership, December 2022

	Delegates	Alternate Delegates	Board of Trustees	Councils and Leadership of Sections and Special Groups	AMA Members	All Physicians and Medical Students
Count	661	391	20	167	274,716	1,455,177
Life Stage						
Student[8]	32	41	1	16	53,542	116,060
Resident[1]	38	34	1	19	71,984	147,487
Young (Under age 40 or first eight years of practice) ^	49	56	-	22	27,193	224,043
Established (Age 40-64) ^	298	172	13	69	59,495	551,790
Senior (Age 65 or more)^	244	88	5	41	62,502	415,797
Present Employment						
Self-employed solo practice	80	33	3	18	16,927	110,247
Two physician practice	11	8	1	2	3,631	25,396
Group practice	263	151	9	58	66,043	577,636
Non-government hospital	51	28	2	11	8,164	59,397
State or local government hospital	68	38	1	12	9,935	86,655
HMO	7	2	0	2	650	2,250
Medical School	26	11	2	6	2,450	20,076
U.S. Government	20	8	0	6	2,279	22,607
Locum Tenens	2	1	0	2	365	2,589
Retired/Inactive	51	18	0	11	31,308	183,396
Resident/Intern/Fellow	38	34	1	19	71,984	147,487
Student	32	41	1	16	53,542	116,060
Other/Unknown	12	18	0	4	7,438	101,381
Self-designated specialty						
Family Medicine	73	43	1	18	24,050	164,511
Internal Medicine	144	59	4	37	56,630	331,181
Surgery	146	68	6	26	36,839	193,274
Pediatrics	23	21	0	12	14,681	126,906
OB/GYN	39	31	3	16	13,549	65,941
Radiology	38	20	1	4	9,809	64,423

[8] Students and residents are so categorized without regard to age.
^ Reflects section/group definition of its membership.

Psychiatry	25	22	0	8	12,014	75,523
Anesthesiology	25	12	1	4	10,798	71,625
Pathology	13	15	0	0	4,748	31,777
Other specialty	103	59	3	26	38,056	213,956
Student	32	41	1	16	53,542	116,060

See Appendix B for a listing of specialty classifications.

Table 5. Demographic Characteristic Cross Sections of AMA Members, December 2022

	White non-Hispanic	Black non-Hispanic	Hispanic	Asian/Asian American	Native American	Other[9]
Mean age[10]	51.8	42.0	45.2	41.4	40.4	43.1
Count	134,244	13,379	12.234	42,310	470	72,079
Age distribution						
Under age 40	42.0%	55.6%	49.7%	58.6%	52.1%	64.3%
40-49 years	10.4%	15.6%	16.2%	15.4%	22.3%	8.5%
50-59 years	10.8%	12.9%	12.8%	11.9%	20.4%	5.4%
60-69 years	12.4%	8.9%	9.4%	5.5%	4.0%	7.1%
70 or more	24.4%	6.9%	11.9%	8.6%	1.1%	14.6%
Gender						
Male	65.5%	44.3%	58.9%	53.3%	52.1%	56.9%
Female	34.5%	55.7%	41.1%	46.7%	47.9%	41.1%
Unknown	0.0%	0.0%	0.1%	0.1%	0.0%	2.1%
Life Stage						
Student[11]	15.5%	24.1%	20.4%	21.5%	21.7%	24.6%
Resident[4]	19.9%	25.6%	26.3%	27.8%	27.2%	37.1%
Young (Under age 40 or first eight years of practice) ^	9.8%	12.9%	5.2%	14.1%	10.0%	7.8%
Established (Age 40-64) ^	24.0%	26.8%	32.0%	25.6%	39.2%	12.2%
Senior (Age 65 or more)^	30.8%	10.8%	16.1%	11.0%	1.9%	18.2%
Education						
US or Canada	92.2%	85.6%	73.5%	67.8%	93.8%	71.6%
IMG	7.8%	14.4%	26.5%	32.2%	6.2%	28.4%

[9] Includes other self-reported racial and ethnic groups.
[10] Age as of December 31. Mean age is the arithmetic average.
[11] Numbers include medical students and residents endorsed by their states for delegate and alternate delegate positions.
^ Reflects section/group definition of its membership.

Table 6. Demographic Characteristics of AMA Section Governing Councils, December 2022

	APS	IPPS	IMGS	MSS	MAS	OMSS	PPPS	RFS	SPS	WPS	YPS
Mean Age	62.4	57.7	42.6	27.3	45.9	65.4	54.9	30.9	71.9	46.3	37.1
Life Stage											
Student	-	-	-	9	-	-	-	-	-	-	-
Resident	-	-	-	-	2	-	-	8	-	1	-
Young (Under age 40 or first eight years of practice) ^	-	-	6	-	1	-	2	-	-	2	7
Established (Age 40-64)^	5	6	1	-	3	3	3	-	1	3	-
Senior (Age 65 or over)^	3	1		-	1	4	2	-	6	1	-
Gender											
Male	4	6	3	4	2	4	3	4	5	-	4
Female	4	1	4	5	5	3	4	4	2	7	3
Unknown	-	-	-	-	-	-	-	-	-	-	-
Race/ethnicity											
White non-Hispanic	4	5	3	4	1	5	5	3	5	3	6
Black non-Hispanic	1	-	-	1	3	-	-	-	-	1	-
Hispanic	1	-	-	1	2	1	-	-	-	-	-
Asian/Asian American	1	1	2	2	-	1	1	1	2	2	-
Native American	-	-	-	-	-	-	-	-	-	-	-
Other[1]	-	-	2	1	1	-	-	3	-	-	1
Unknown	1	1	-	-	-	-	1	1	-	1	-
Education											
US or Canada	7	5	-	9	7	6	6	8	6	7	7
IMG	1	2	7	-	-	1	1	-	1	-	-

^ Reflects section/group definition of its membership.
[1] Includes other self-reported racial and ethnic groups.

Table 7. Characteristics of Specialty Society Delegations, December 2022

	Mean Age	% Female	% IMG	% Resident
AMA Members (n =274,716)	47.1	39.5%	18.1%	26.2%
Specialty Society Delegates and Alternates (n =418)	55.3	38.5%	7.9%	2.9%
Family Medicine Delegations (n =30)	52.9	50.0%	6.7%	3.3%
Internal Medicine Delegations (n =92)	57.1	38.0%	13.0%	4.4%
Surgery Delegations (n = 90)	56.0	23.3%	7.8%	2.2%
Pediatrics Delegations (n = 12)	52.3	83.3%	0.0%	0.0%
OB/GYN Delegations (n = 28)	54.8	71.4%	7.1%	3.6%
Radiology Delegations (n = 34)	56.1	35.3%	5.9%	0.0%
Psychiatry Delegations (n =22)	54.1	45.5%	9.1%	0.0%
Anesthesiology Delegations (n =13)	56.2	15.4%	0.0%	0.0%
Pathology Delegations (n =20)	54.5	30.0%	5.0%	0.0%
Other specialty Delegations (n =77)	53.7	39.0%	6.5%	5.2%

Table 8. Mean Age of AMA Members and Delegations by State, December 2022

State	Total AMA Members in State	Mean Age of AMA Members	Total Number of Delegates and Alternate Delegates	Mean Age of AMA Delegates and Alternate Delegates
Alabama	3,073	51.9	8	58.6
Alaska	349	56.2	2	†
Arizona	4,632	54.7	10	61.1
Arkansas	1,948	52.3	5	63.4
California	31,743	55.0	62	54.3
Colorado	5,486	53.0	8	56.1
Connecticut	3,072	53.4	8	62.8
Delaware	835	55.6	2	†
District of Columbia	1,957	45.6	3	†
Florida	16,122	55.9	30	59.1
Georgia	5,901	52.6	11	59.3
Guam	20	59.3		
Hawaii	997	56.8	3	†
Idaho	774	55.9	2	†
Illinois	11,329	51.9	23	63.3
Indiana	4,646	52.5	9	65.2
Iowa	3,162	52.6	6	54.0
Kansas	2,251	52.5	7	63.1
Kentucky	3,999	51.5	8	62.5
Louisiana	5,906	50.0	7	52.1
Maine	1,144	55.4	2	†
Maryland	5,084	54.5	10	59.1
Massachusetts	12,481	51.2	19	57.0
Michigan	13,192	50.5	26	57.7
Minnesota	4,681	52.8	10	59.2
Mississippi	2,728	51.4	6	56.5
Missouri	4,900	49.3	9	59.9
Montana	684	57.1	2	†
Nebraska	1,654	49.0	4	47.8
Nevada	1,683	54.1	4	71.8
New Hampshire	893	54.9	3	†
New Jersey	7,603	54.6	12	67.1
New Mexico	1,187	55.7	4	55.0
New York	19,600	52.4	22	56.8
North Carolina	5,259	51.9	6	61.2
North Dakota	722	51.0	2	†
Ohio	10,214	50.7	18	51.3
Oklahoma	3,314	52.0	7	63.1
Oregon	3,145	54.9	5	58.4
Other	793	67.9	1	†
Pennsylvania	11,663	51.7	23	59.5
Puerto Rico	1,440	55.8	1	†
Rhode Island	1,030	50.4	5	61.8
South Carolina	3,683	51.7	10	64.3
South Dakota	975	52.2	5	63.6

† To protect the privacy of these individuals, data for three or fewer persons are not presented in the table, although the data are included in the overall total.

State	Total AMA Members in State	Mean Age of AMA Members	Total Number of Delegates and Alternate Delegates	Mean Age of AMA Delegates and Alternate Delegates
Tennessee	5,422	52.0	11	62.4
Texas	19,908	50.9	35	59.9
Utah	1,799	50.5	4	52.5
Vermont	460	53.0	1	†
Virgin Islands	29	65.2		
Virginia	7,000	53.0	10	60.4
Washington	5,445	54.8	10	49.7
West Virginia	1,872	50.1		
Wisconsin	4,621	52.8	7	62.0
Wyoming	206	59.1	2	†
TOTAL	274,716	53.1	510	59.1

Table 9. Women and International Medical Graduates on State Association Delegations, December 2022

State	Total AMA Members in State	Total Number of Delegates and Alternate Delegates	Percentage of female AMA Members in State	Number of Female Delegates and Alternate Delegates	Percentage of IMG Members in State	Number of IMG Delegates and Alternate Delegates
Alabama	3,073	8	34.0%	3	12.6%	-
Alaska	349	2	40.4%	1	10.0%	-
Arizona	4,632	10	36.0%	4	15.0%	-
Arkansas	1,948	5	37.2%	1	13.1%	1
California	31,743	62	41.0%	20	18.2%	3
Colorado	5,486	8	43.8%	5	5.9%	-
Connecticut	3,072	8	40.1%	4	21.2%	2
Delaware	835	2	34.6%	2	28.9%	-
District of Columbia	1,957	3	51.3%	-	12.1%	-
Florida	16,122	30	35.2%	9	29.4%	4
Georgia	5,901	11	40.8%	3	17.9%	1
Guam	20	-	15.0%	-	60.0%	-
Hawaii	997	3	34.0%	1	12.7%	-
Idaho	774	2	29.5%	1	5.8%	-
Illinois	11,329	23	39.6%	8	21.6%	6
Indiana	4,646	9	36.4%	2	16.0%	2
Iowa	3,162	6	36.1%	3	16.1%	-
Kansas	2,251	7	34.3%	2	12.8%	1
Kentucky	3,999	8	37.9%	1	14.3%	-
Louisiana	5,906	7	41.5%	-	15.5%	1
Maine	1,144	2	44.8%	1	8.4%	-
Maryland	5,084	10	43.0%	5	23.6%	3
Massachusetts	12,481	19	48.3%	7	15.0%	1
Michigan	13,192	26	38.6%	8	22.5%	4
Minnesota	4,681	10	38.9%	5	14.8%	-
Mississippi	2,728	6	33.7%	2	10.5%	1
Missouri	4,900	9	39.6%	3	10.4%	2
Montana	684	2	42.3%	1	4.5%	-
Nebraska	1,654	4	39.4%	1	8.0%	-
Nevada	1,683	4	35.8%	1	19.4%	1
New Hampshire	893	3	37.1%	1	16.9%	-
New Jersey	7,603	12	37.1%	4	29.2%	2
New Mexico	1,187	4	38.6%	2	14.2%	-
New York	19,600	22	40.7%	3	27.2%	2
North Carolina	5,259	6	36.1%	4	13.4%	-
North Dakota	722	2	38.6%	-	15.2%	1
Ohio	10,214	18	39.7%	6	15.8%	1
Oklahoma	3,314	7	36.6%	2	11.1%	-
Oregon	3,145	5	41.9%	1	8.7%	-
Other	793	1	16.3%	1	56.0%	-
Pennsylvania	11,663	23	37.1%	1	15.5%	4
Puerto Rico	1,440	1	43.3%	-	20.1%	-
Rhode Island	1,030	5	43.7%	2	16.3%	-
South Carolina	3,683	10	39.6%	1	8.9%	-
South Dakota	975	5	37.2%	1	10.1%	1
Tennessee	5,422	11	38.8%	3	10.3%	2

State	Total AMA Members in State	Total Number of Delegates and Alternate Delegates	Percentage of female AMA Members in State	Number of Female Delegates and Alternate Delegates	Percentage of IMG Members in State	Number of IMG Delegates and Alternate Delegates
Texas	19,908	35	40.8%	11	17.6%	4
Utah	1,799	4	26.6%	2	5.5%	-
Vermont	460	1	39.8%	-	9.3%	-
Virgin Islands	29	-	27.6%	-	31.0%	-
Virginia	7,000	10	41.5%	5	17.4%	1
Washington	5,445	10	39.6%	5	15.1%	1
West Virginia	1,872	-	36.7%	-	22.8%	-
Wisconsin	4,621	7	36.8%	3	16.7%	1
Wyoming	206	2	28.2%	-	11.2%	-
TOTAL	274,716	510	39.4%	162	18.1%	53

Table 10. Medical Students and Resident Physicians on State Association Delegations, December 2022

State	Total AMA Members in State	Number of State Delegates and Alternate Delegates	Total Medical Student AMA Members in State	Number of Medical Student Delegates and Alternate Delegates	Number of Regional Medical Student Delegates and Alternate Delegates[1]	Total Resident Physician AMA Members in State	Number of Resident Delegates and Alternate Delegates	Number of Sectional Resident Delegates and Alternate Delegates[2]
Alabama	3,073	8	501	1	1	879	1	1
Alaska	349	2	5	-	-	33	-	-
Arizona	4,632	9	833	1	1	1,505	2	-
Arkansas	1,948	5	570	1	1	376	-	-
California	31,743	61	3,416	7	5	6,642	7	2
Colorado	5,486	8	1,651	1	1	691	-	-
Connecticut	3,072	6	689	3	3	665	-	-
Delaware	835	2	22	-	-	107	-	-
District of Columbia	1,957	2	678	-	-	526	2	2
Florida	16,122	30	2,598	3	3	4,460	-	-
Georgia	5,901	11	1,058	2	2	1,149	-	-
Guam	20	-	-	-	-	2	-	-
Hawaii	997	3	156	-	-	118	-	-
Idaho	774	2	112	-	-	66	-	-
Illinois	11,329	23	2,727	2	1	2,522	5	1
Indiana	4,646	9	626	3	3	1,644	-	-
Iowa	3,162	6	386	-	-	769	-	-
Kansas	2,251	7	537	-	-	409	-	-
Kentucky	3,999	8	917	1	1	846	1	1
Louisiana	5,906	7	1,107	2	2	2,068	2	-
Maine	1,144	2	382	-	-	201	-	-
Maryland	5,084	10	610	1	1	935	1	-
Massachusetts	12,481	19	3,396	6	5	5,344	5	2
Michigan	13,192	25	1,847	2	1	5,085	1	-
Minnesota	4,681	10	634	1	1	1,428	-	-

Table 10. Medical Students and Resident Physicians on State Association Delegations, December 2022

State	Total AMA Members in State	Number of State Delegates and Alternate Delegates	Total Medical Student AMA Members in State	Number of Medical Student Delegates and Alternate Delegates	Number of Regional Medical Student Delegates and Alternate Delegates[1]	Total Resident Physician AMA Members in State	Number of Resident Delegates and Alternate Delegates	Number of Sectional Resident Delegates and Alternate Delegates[2]
Mississippi	2,728	6	626	1	1	740	1	1
Missouri	4,900	8	1,523	1	1	1,286	1	1
Montana	684	2	273	-	-	38	-	-
Nebraska	1,654	3	644	1	1	234	1	1
Nevada	1,683	4	328	-	-	491	2	2
New Hampshire	893	3	140	-	-	166	-	-
New Jersey	7,603	12	1,231	2	2	1,561	-	-
New Mexico	1,187	4	231	-	-	170	-	-
New York	19,600	18	4,029	4	3	6,231	-	-
North Carolina	5,259	6	815	-	-	1,288	1	-
North Dakota	722	2	340	-	-	84	-	-
Ohio	10,214	17	2,792	4	3	2,617	2	1
Oklahoma	3,314	5	1,030	-	-	849	-	-
Oregon	3,145	5	311	-	-	464	-	-
Other	793	1	22	-	-	66	-	-
Pennsylvania	11,663	22	2,210	3	2	3,007	2	-
Puerto Rico	1,440	1	578	-	-	280	-	-
Rhode Island	1,030	5	265	-	-	262	-	-
South Carolina	3,683	10	1,114	2	2	827	-	-
South Dakota	975	5	350	-	-	130	-	-
Tennessee	5,422	11	1,324	-	-	1,632	1	-
Texas	19,908	32	4,346	5	4	6,497	5	4
Utah	1,799	3	337	-	-	325	-	-
Vermont	460	1	98	-	-	97	-	-
Virgin Islands	29	-	-	-	-	-	-	-
Virginia	7,000	10	1,642	2	2	1,423	1	-
Washington	5,445	9	440	-	-	676	-	-

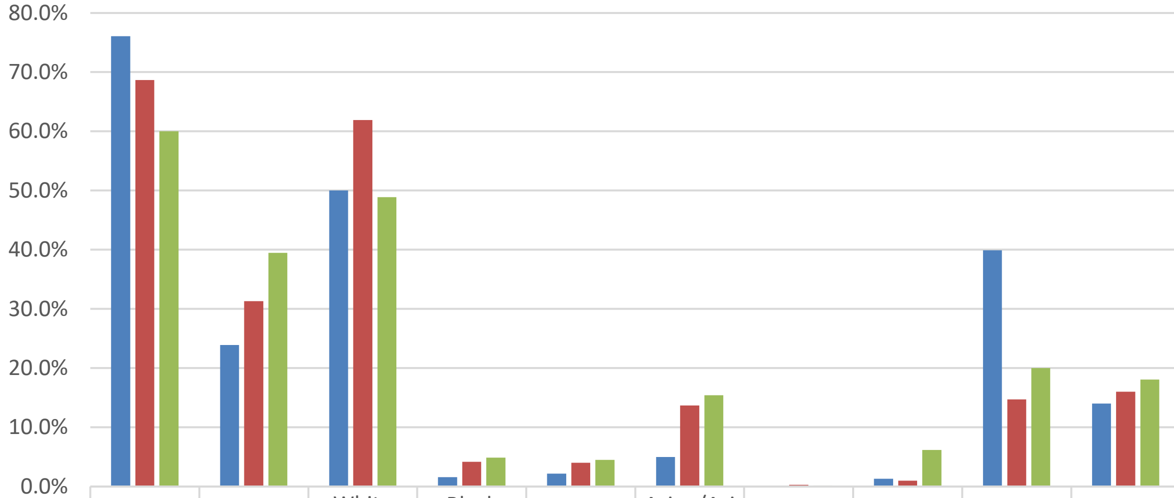
Table 10. Medical Students and Resident Physicians on State Association Delegations, December 2022

State	Total AMA Members in State	Number of State Delegates and Alternate Delegates	Total Medical Student AMA Members in State	Number of Medical Student Delegates and Alternate Delegates	Number of Regional Medical Student Delegates and Alternate Delegates[1]	Total Resident Physician AMA Members in State	Number of Resident Delegates and Alternate Delegates	Number of Sectional Resident Delegates and Alternate Delegates[2]
West Virginia	1,872	-	371	-	-	774	-	-
Wisconsin	4,621	6	671	1	1	1,273	1	1
Wyoming	206	2	3	-	-	18	-	-
TOTAL	274,716	488	53,542	63	54	71,976	45	20

[1] The Medical Student Section elects AMA delegates and alternate delegates from Medical Student Regions. There are seven Medical Student Regions defined for the purposes of electing AMA Delegates from Medical Student Regions. Each Region is entitled to delegate and alternate delegate representation based on the number of seats allocated to it by apportionment. A delegate is seated with the state delegation in which his or her medical school resides.

[2] Resident sectional delegates and alternate delegates endorsed by specialty societies were not included in this table. The following specialty societies endorsed sectional resident delegates and alternate delegates: American Academy of Family Physicians, American Academy of Neurology, American Academy of Pediatrics, American Association of Neurological Surgeons, American Association of Public Health Physicians, American College of Emergency Physicians, American Geriatrics Society, American Psychiatric Association, American Urological Association, Infectious Diseases Society of America, and Society of Critical Care Medicine. This table reflects information available as of January 31, 2023, and is subject to change. Information on alternate delegates was not available.

Figure 1. Demographic Characteristics of AMA Members, 2002-2022



	Male	Female	White non-Hispanic	Black non-Hispanic	Hispanic	Asian/Asian American	Native American	Other	Unknown	IMG
2002	76.1%	23.9%	50.0%	1.6%	2.2%	5.0%	0.0%	1.3%	39.9%	14.0%
2012	68.7%	31.3%	61.9%	4.2%	4.0%	13.7%	0.3%	1.0%	14.7%	16.0%
2022	60.0%	39.5%	48.9%	4.9%	4.5%	15.4%	0.2%	6.2%	20.0%	18.1%

Figure 2. Self-Identified Race/Ethnicity of Delegates and Alternate Delegates, 2002-2022

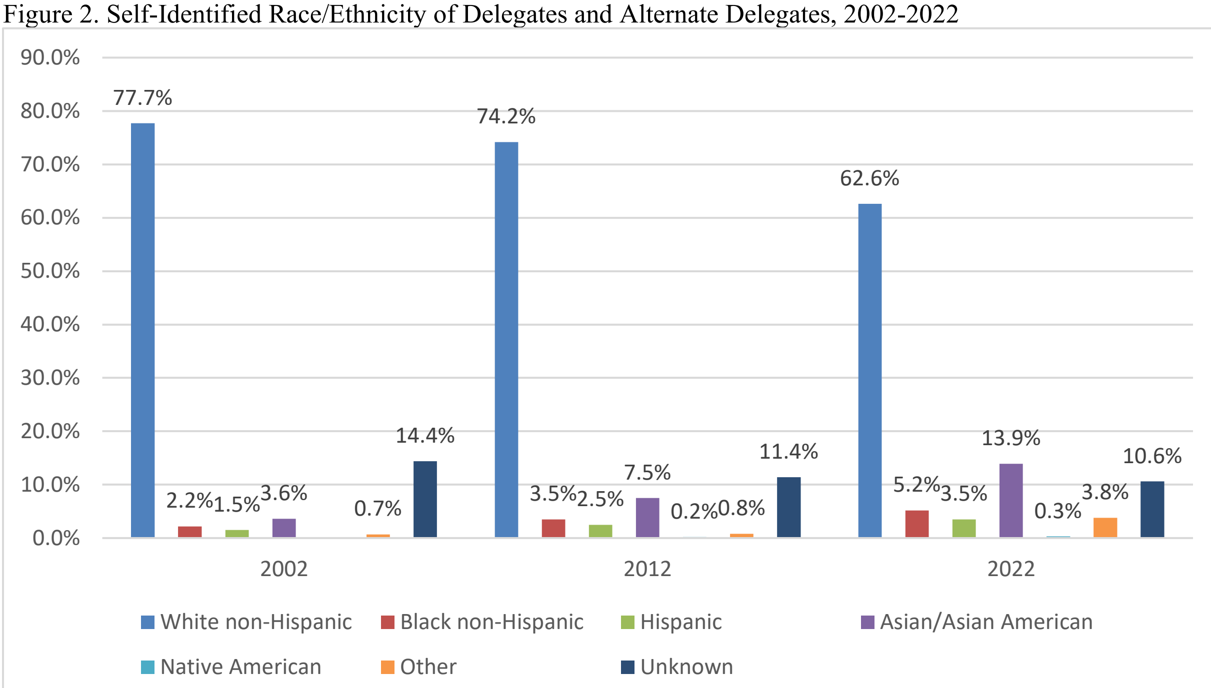


Figure 3. Self-Identified Race/Ethnicity of AMA Board of Trustees, 2002-2022

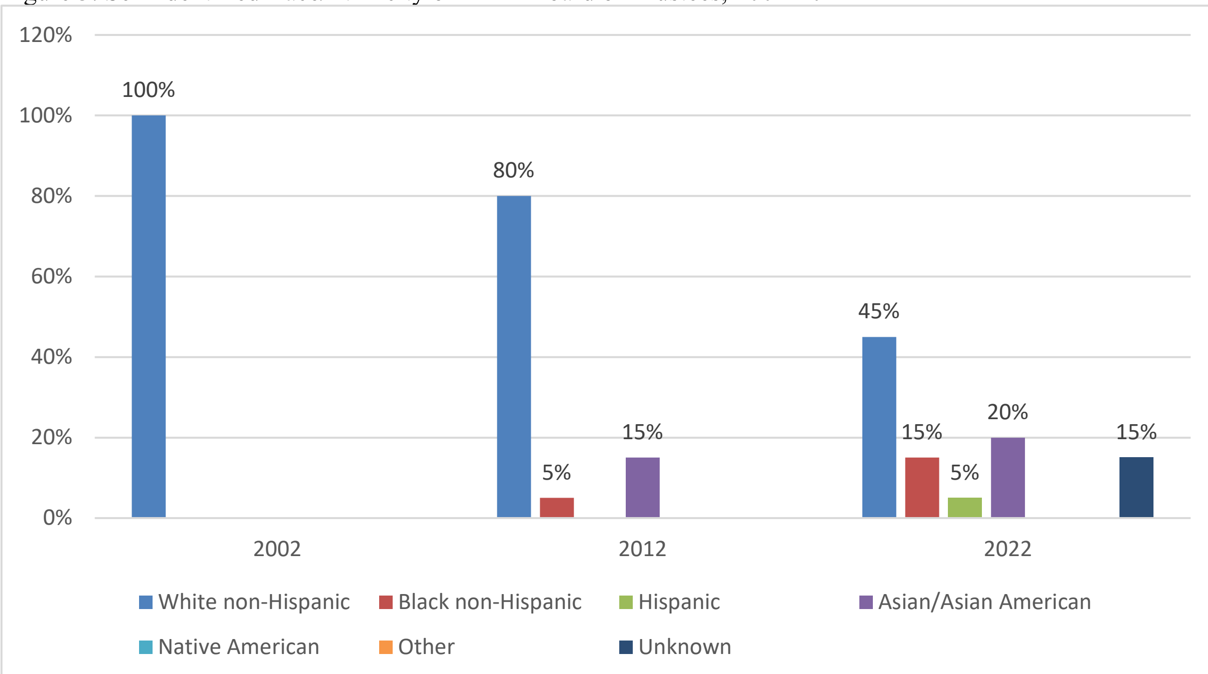


Figure 4. Self-Identified Race/Ethnicity of Councils and Section and Special Group Leadership, 2012-2022

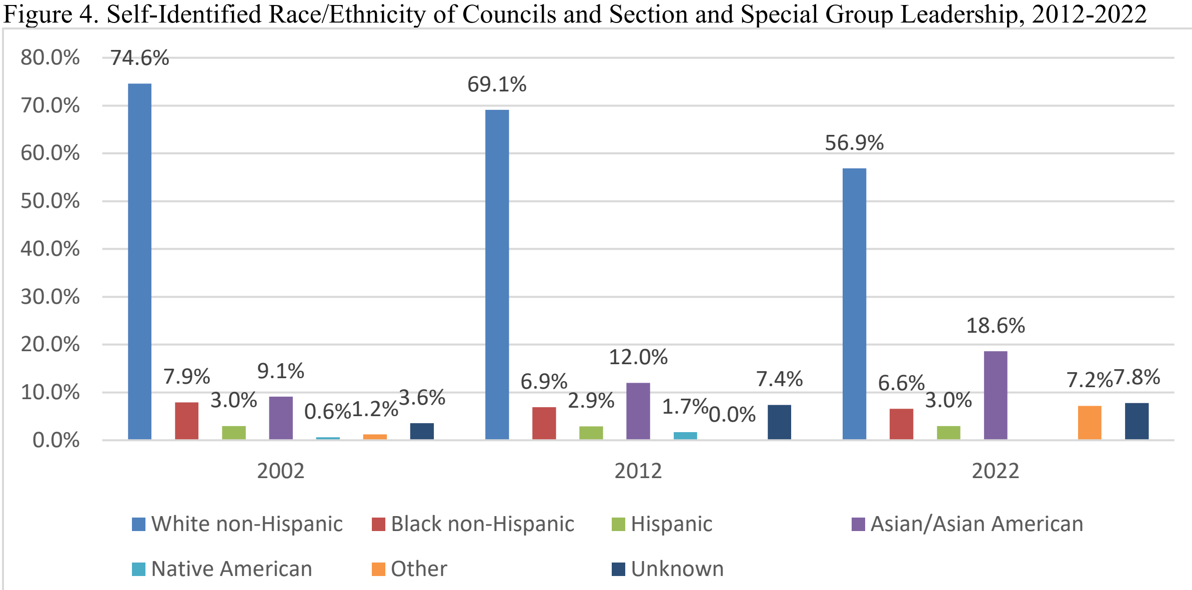
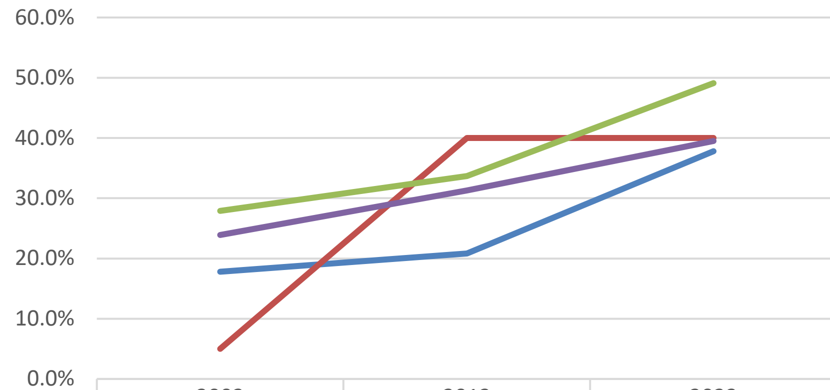
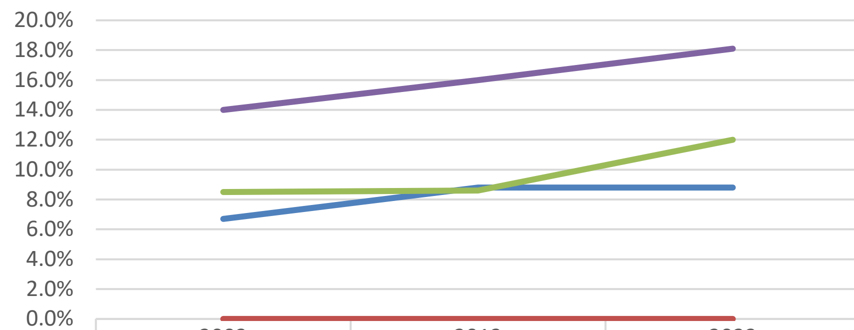


Figure 5. Percentage of Female AMA Leadership, 2002-2022



	2002	2012	2022
Delegates and Alternate Delegates	17.8%	20.8%	37.8%
Board of Trustees	5.0%	40.0%	40.0%
Councils and Leadership of AMA Sections and Special Groups	27.9%	33.7%	49.1%
AMA Members	23.9%	31.3%	39.5%

Figure 6. Percentage of IMG AMA Leadership, 2002-2022



	2002	2012	2022
Delegates and Alternate Delegates	6.7%	8.8%	8.8%
Board of Trustees	0.0%	0.0%	0.0%
Councils and Leadership of AMA Sections and Special Groups	8.5%	8.6%	12.0%
AMA Members	14.0%	16.0%	18.1%

APPENDIX B

Specialty classification using physicians' self-designated specialties

Major Specialty Classification	AMA Physician Masterfile Classification
Family Practice	General Practice, Family Practice
Internal Medicine	Internal Medicine, Allergy, Allergy and Immunology, Cardiovascular Diseases, Diabetes, Diagnostic Laboratory Immunology, Endocrinology, Gastroenterology, Geriatrics, Hematology, Immunology, Infectious Diseases, Nephrology, Nutrition, Medical Oncology, Pulmonary Disease, Rheumatology
Surgery	General Surgery, Otolaryngology, Ophthalmology, Neurological Surgery, Orthopedic Surgery, Plastic Surgery, Colon and Rectal Surgery, Thoracic Surgery, Urological Surgery
Pediatrics	Pediatrics, Pediatric Allergy, Pediatric Cardiology
Obstetrics/Gynecology	Obstetrics and Gynecology
Radiology	Diagnostic Radiology, Radiology, Radiation Oncology
Psychiatry	Psychiatry, Child Psychiatry
Anesthesiology	Anesthesiology
Pathology	Forensic Pathology, Pathology
Other Specialty	Aerospace Medicine, Dermatology, Emergency Medicine, General Preventive Medicine, Neurology, Nuclear Medicine, Occupational Medicine, Physical Medicine and Rehabilitation, Public Health, Other Specialty, Unspecified

American Medical Association Councils, Sections and Special Groups

COUNCILS

- American Medical Political Action Committee
- Council on Constitution and Bylaws
- Council on Ethical and Judicial Affairs
- Council on Legislation
- Council on Long Range Planning and Development
- Council on Medical Education
- Council on Medical Service
- Council on Science and Public Health

SECTIONS

- Academic Physicians Section
- Integrated Physician Practice Section
- International Medical Graduates Section
- Medical Student Section
- Minority Affairs Section
- Organized Medical Staff Section
- Private Practice Physicians Section
- Resident and Fellow Section
- Senior Physicians Section
- Young Physicians Section
- Women Physicians Section

SPECIAL GROUPS

- Advisory Committee on LGBTQ Issues

Specialty classification using physicians' self-designated specialties

Major Specialty Classification	AMA Physician Masterfile Classification
Family Practice	General Practice, Family Practice
Internal Medicine	Internal Medicine, Allergy, Allergy and Immunology, Cardiovascular Diseases, Diabetes, Diagnostic Laboratory Immunology, Endocrinology, Gastroenterology, Geriatrics, Hematology, Immunology, Infectious Diseases, Nephrology, Nutrition, Medical Oncology, Pulmonary Disease, Rheumatology
Surgery	General Surgery, Otolaryngology, Ophthalmology, Neurological Surgery, Orthopedic Surgery, Plastic Surgery, Colon and Rectal Surgery, Thoracic Surgery, Urological Surgery
Pediatrics	Pediatrics, Pediatric Allergy, Pediatric Cardiology
Obstetrics/Gynecology	Obstetrics and Gynecology
Radiology	Diagnostic Radiology, Radiology, Radiation Oncology
Psychiatry	Psychiatry, Child Psychiatry
Anesthesiology	Anesthesiology
Pathology	Forensic Pathology, Pathology
Other Specialty	Aerospace Medicine, Dermatology, Emergency Medicine, General Preventive Medicine, Neurology, Nuclear Medicine, Occupational Medicine, Physical Medicine and Rehabilitation, Public Health, Other Specialty, Unspecified

2. A PRIMER ON THE MEDICAL SUPPLY CHAIN

Informational report; no reference committee hearing.

HOUSE ACTION: FILED

The critical medical shortages that resulted from COVID-19 hampered the pandemic response and cascaded into defaults of other aspects of U.S. health care delivery. This informational report was developed to provide members of the House of Delegates (HOD) with some history of medical supply chain shortages, the structure of the medical supply chain, globalization of the U.S. medical supply chain, causes and consequences of failures, U.S. governmental actions to mitigate issues, and onshoring and nearshoring strategies for the U.S. medical supply chain. It also identifies opportunities for physicians and health systems to improve medical supply chain resilience and performance.

BRIEF HISTORY OF U.S. MEDICAL SUPPLY CHAIN SHORTAGES

Shortages of medical supplies in the United States due to supply chain issues are not new.

- During War II, the supply of quinine that was primarily sourced in the Japanese-occupied East Indies, was cut off. The United States suddenly found itself facing malaria across the globe without sufficient treatment, which resulted in major hospitalizations from malarial infections throughout different battles and theaters.[1]
- In September 2017, Hurricane Maria devastated the territory of Puerto Rico—producer of 50% of America's supply of intravenous saline—catapulting hospitals nationwide into a shortage.[2]
- In late 2019, SARS-CoV-2 emerged from China and rapidly evolved into a pandemic, resulting in disrupted production and export of medications and personal protective equipment (PPE) around the world.

The critical medical shortages that resulted from COVID-19 hampered the pandemic response and cascaded into defaults of other aspects of U.S. health care delivery. What differentiates COVID-19 from prior supply chain disruptions is the level of uncertainty and the length of the disruption, as well as its simultaneous global impact. Additionally, unlike most other disruptions, COVID-19 has affected not only the supply of, but also the demand for products and services.

MEDICAL SUPPLY CHAIN STRUCTURE

The medical supply chain is an extensive network of systems, components, and processes that collectively work to ensure medicines and other health care supplies are manufactured, distributed, and provided to patients. In the broadest sense, a supply chain includes all activities related to manufacturing, the extraction of raw materials, processing, warehousing, and transportation. Hence, for large multinational companies that manufacture complex products supply chains are highly complex socioeconomic systems. There are many players in the medical supply chain; however, manufacturers and distributors are particularly prominent.

- Manufacturers are the first link in the supply chain and make the medicines and health care supplies patients and physicians rely on. Manufacturers acquire raw materials for production of approved products; conduct research, develop, and process medicines and products; identify what product(s) is needed and if enough supply will be available based on demand; conduct safety trial testing; and package approved products for distribution.
- Distributors are the second link in the medical supply chain. Distributors repackage, relabel, and ensure special handling for unique products; obtain medicines and products from manufacturing facilities and distribute to providers, health care facilities or other general areas of need; and manage temperature and climate conditions for safe transportation of medicines and products. Distributors purchase drugs and medical products in bulk from manufacturers and maintain large stocks in strategic locations across the country. Some wholesalers specialize in dealing with a particular range of products, such as biologics or to specific types of customers.

- Providers (hospitals, pharmacies, dialysis centers, urgent care, assisted living, and long-term care facilities) submit orders to distributors; refill prescriptions for patients; and identify shortages in inventory and potential distribution challenges.
- Patients and communities with unique medical needs that require specific products influence the demand for medicines and products.

To strengthen and stabilize the medical supply chain, it is important to understand the various aspects of the medical supply chain, to identify the challenges that resulted in supply chain disruptions during the pandemic, and to consider several strategies to mitigate medical supply chain disruptions for the future.

GLOBALIZATION OF U.S. MEDICAL SUPPLY CHAIN

Over decades, the medical supply chain has assembled substantial global networks; however, the COVID-19 pandemic has exposed structural weaknesses and cracks within these networks. Many medical supply distributors and health systems had adopted a "just-in-time" approach to supplies, by which they stocked only what they immediately needed and trusted supply chains to deliver other items quickly. That approach saved money because firms and hospitals did not need to build extended storage facilities or keep full inventories. Rather, they kept their stocks low and refreshed on an "as needed" basis.[3] At the same time, much of America's manufacturing capacity shifted abroad, where products could be made inexpensively with low labor and energy costs.[4] Further, while American manufacturing's share of overall output remained constant, its labor share declined as firms automated production lines and relied upon emerging technologies.[5] That production and distribution system worked as planned until issues in the global supply chain disrupted those practices, creating problems in terms of supply, safety, and security.

The National Academies of Sciences, Engineering, and Medicine (NASEM) reported that only 28% of the manufacturing facilities making active pharmaceutical ingredients (APIs) for the U.S. market were in the United States as of August 2019. This means that 72% of the medical supplies and APIs for making drugs found in the United States had resulted from outsourcing to other countries. A previous shortfall occurred with the anticoagulant heparin, made using pig intestines: China makes 80% of the world's heparin and 60% of the U.S. supply. In 2007, an infectious disease outbreak in Asia decimated pig herds, pushing heparin into short supply and doubling prices. Seeking a rapid, practical solution, the U.S. Food and Drug Administration (FDA) suggested using U.S. bovine heparin and asked manufacturers to submit applications that demonstrated safety, efficacy, quality, and purity. Although the FDA cannot eliminate all possible risk, it can enforce requirements, controls, and best practices to detect problems early while ensuring the availability of safe and effective medications.[6]

As COVID-19 became a pandemic, different countries took steps to protect their local supplies by limiting or stopping exports entirely. For example, China, which produces roughly 50% of the global supply of masks at 10 million masks daily, ramped up production to 115 million daily during the early phases of COVID-19, yet simultaneously terminated all mask exports, leading to a gradual depletion of global stockpiles. Additionally, Germany banned the export of most of its PPE supplies. In other areas where local production was not significant, essential equipment procurement became vulnerable.

Virus mitigation measures continue to affect production and limit efforts to return the supply chain to pre-pandemic levels. Several industry players have reduced worker levels due to fears of the further spread of COVID-19 within the workplaces. In China, port terminals temporarily closed because of the country's COVID-19 zero-tolerance policy, creating lengthy shipping backlogs at some of the world's largest ports. While consumer demand can increase in months, more time is required to increase port capacity, build warehouses, and hire employees so that shipping can meet the needs of the demand.

Problems include a wide array of medical supply and equipment shortages that can be traced to component scarcities, factory closures, backlogged ports, transportation glitches, and COVID-19 lockdowns across the global supply chain. According to the FDA, the list of persistently scarce items is long and includes latex and vinyl examination gloves, surgical gowns, laboratory reagents, specimen-collection testing supplies, saline-flush syringes, and dialysis-related products.[7]

CAUSES AND CONSEQUENCES OF MEDICAL SUPPLY CHAIN FAILURES

Factors that disrupt medical supply chains include infectious disease outbreaks, geopolitical conflict, economic conditions, and quality-related issues at production sites. These factors can impact daily health care, as well as the profitability of manufacturing companies. Once there is an infectious outbreak, it may be difficult to access treatment and other health services, especially if the outbreak comes with harsh control measures such as quarantines and lockdowns. Such measures may generate an acute surge in the demand for critical medical supplies and equipment, which exceeds supply, leading to shortages and protocols for prioritized use. A disruptive event can cause a mismatch between supply and demand in medical product supply chains in three ways:

1. Demand surge: An event drives demand for a medical product well above the normal level for an extended period. For example, a major natural disaster, such as a tornado or earthquake, can spike regional demand for certain medical products if these events result in a significant number of casualties requiring medical care. As seen during COVID-19, a pandemic can drive up global demand for many medical products.
2. Capacity reduction: One or more production or transport processes are impeded by lack of assets, power, or people. For example, a natural disaster could cause a factory to lose power and halt production, or regulatory barriers or manufacturing quality problems could restrict the output of a supplier or producer and could even eliminate inventory stock if a product is recalled. As seen during the COVID-19 pandemic, production of some products decreased because of lockdown measures, as well as acute loss of workers to quarantine and illness.
3. Coordination failure: Events that prevent coordination of supply to meet demand can cause shortages of medical products even when total supply is sufficient to meet total demand. For example, geopolitical issues or communication system failures during a hurricane or other natural disaster can reduce or obstruct the delivery of emergency supplies into a city or region.[8]

The COVID-19 pandemic led to such shortages in medical supplies as a combination of all three ways, leading to gaps in medical supplies for routine health care (e.g., dialysis-related products) and pandemic response (e.g., PPE, lab testing supplies and equipment, and ventilation-related products) in most health care facilities around the world.

The medical supply chain may be influenced by U.S. insurance companies, hospitals, physicians, employers, and regulatory agencies, with differing objectives among them. Demand for services is determined by both available treatments and insurance coverage for those treatments. Decisions made by one party often affect the options available to other parties, as well as the costs of these options, in ways that are not well understood. Most of these complicated factors are also present, to varying degrees, in industrial supply chains.

In 2021, virtually all U.S. hospitals and health care systems (99%) reported challenges in procuring needed supplies, including shortages of key items and significant price increases. A Kaufman Hall report noted that 80% of hospitals had significant supply shortages and had to seek new vendors for supplies during the pandemic. Shortages in raw materials and components hampered the production of both drugs and sophisticated medical devices. Manufacturing facilities struggled to keep up as COVID-19 swept through the workplace. Labor shortages prevented medical products from being transported to the places where they were needed most.[9]

Helium, a nonrenewable element found deep within the earth's crust, is essential for keeping magnetic resonance imaging (MRI) machines cool enough to work. With a boiling point of minus 452 degrees Fahrenheit, liquid helium is the coldest element on Earth. Pumped inside an MRI magnet, helium lets the current travel resistance-free. However, the supply of helium is running low leaving hospitals wondering how to plan with a much scarcer supply. Currently, four of five major U.S. helium suppliers are rationing the element.[10] Shortages in aluminum, semiconductors, wood and paper pulp, and resin are disrupting supplies of medical devices, with different business sectors competing for the same raw materials. Those shortages have led to uneven supplies of medical monitors, CT scan devices, packaging for medical supplies, and gloves. While only a fraction of the world's semiconductors is in medical equipment compared with cars and consumer electronics, the components are key to a range of medical devices such as MRI machines, pacemakers, glucose monitors, CT scanners, defibrillators, multiparameter monitors, and ultrasound machines. As a result, hospitals are experiencing long order delays for equipment because of the semiconductor shortage.[11]

Drugs used in the United States involve raw materials from all over the world. Many chemical inputs are manufactured in India and China and then shipped to the United States. Regardless of the root cause, drug shortages can lead to substitutions for available medications that are costlier and/or less effective. In some instances, hospital pharmacies must compound and modify products, which adds workload and potential error.[12] The American Medical Association (AMA) Council on Science and Public Health (CSAPH) has issued eleven reports on drug shortages. AMA Policy H-100.956, "National Drug Shortages," directs the CSAPH to continue to evaluate the drug shortage issue and report back at least annually to the House of Delegates on progress made in addressing drug shortages in the United States. CSAPH Report 01-I-22 provides an update on continuing trends in national drug shortages and ongoing efforts to further evaluate and address this critical public health issue.[13]

The United States recently experienced a surge in respiratory illnesses, a potential "tripledemic" of three viruses: respiratory syncytial virus the influenza virus, and the COVID-19 coronavirus. While antibiotics like amoxicillin typically are not effective against such respiratory viruses, they can be important treatments for secondary bacterial infections that may occur when respiratory tract defenses and the immune system in general are battling a viral infection. Despite the best efforts to address root causes of drug shortages, the United States has a dysfunctional, opaque medical supply chain. There is still no easy way to scale up production to meet excess demand. Moreover, there remains a limited profit motive to do better, particularly for low-cost medications such as amoxicillin.

U.S. GOVERNMENT ACTIONS TO MITIGATE MEDICAL SUPPLY CHAIN ISSUES

During the COVID-19 public health emergency, the FDA took many actions to ensure that health care professionals had timely and continued access to high-quality medical devices. These actions included *Emergency Use Authorizations)* and guidance permits to expand available resources for diagnostic, therapeutic, and medical devices in high demand. Further, President Trump invoked the *Defense Production Act* and released government funds to help American companies build facilities and expand production capabilities for medical equipment.[14]

In October 2020, in response to Executive Order 1394410, the FDA published a *List of Essential Medicines, Medical Countermeasures, and Critical Inputs* (described herein as EM). This executive order sought to ensure sufficient, reliable, and long-term domestic production of these products and minimize potential shortages. The published EM list contained 227 drug and biological product essential medicines and countermeasures, including analgesics, antivirals, anticoagulants, antihypertensives, and antimicrobials.[15] The *Center for Drug Evaluation and Research (CDER) Site Catalog* includes approximately 1,100 locations that manufacture at least one product on the EM list. There are 1,686 sites that manufacture an active pharmaceutical ingredient (API), of which 354 manufacture API for EM products. Currently, 23% of API manufacturing sites are in the United States; for EM, this drops to 19%. These data illustrate that only a minority of drug manufacturing sites are domestic. Overall, API and finish dose form manufacturing are heavily dependent on foreign manufacturing sites.

Since early 2020, the United States has made progress in strengthening the health care supply chain by addressing concerns regarding domestic manufacturing and supply chain surge capabilities. In 2021, President Biden issued Executive Order (EO) 14017, *On America's Supply Chains*. The 100-Day Review under this order directed the U.S. Department of Health and Human Services (HHS) to identify products for which onshoring (bringing production back to the U.S.) may be advisable. HHS subsequently issued a 2022 report that identifies successes and practical strategies to further U.S. goals for America's supply chain and industrial base. Particular efforts should be directed at expanding the public health industrial base by working across government agencies, academia, and the private sector, and strengthening capabilities to monitor and manage supply chain bottlenecks.[16] Note that Section 510(j)(3) of *the Food, Drug and Cosmetic (FD&C) Act*, which was added by the recent *CARES Act,* requires FDA registered sites to report annually the amounts of drugs manufactured for U.S. commercial distribution. Combined with FDA information about the location of manufacturing sites, these data should enable the FDA to perform better manufacturing site surveillance.[17]

In 2020, the FDA reported 43 new drug shortages after a peak of 251 shortages in 2011.[18] On the surface, this looks like tremendous progress; however, this measurement does not consider the scope, scale, or severity of the shortage. The FDA metric measures every shortage the same way, whether a drug is dispensed 20 times or 20,000 times a month. Moreover, not every shortage is the same. In response to the public health crisis, some U.S. hospital groups, startups, and nonprofits began making their own sterile injectables and other medicines as a short-term workaround to combat persistent drug shortages.[19] Experts anticipate that efforts by hospitals to have more direct control over their critical drug supply chains will continue to evolve as they work to find a sustainable, cost-effective, and safe model. Joint public-private sector efforts, such as the creation of a *Strategic Active Pharmaceutical Ingredient Reserve (SAPIR),* will be instrumental in defining how these products are supplied in the future.[20]

The 2013 *Drug Supply Chain Security Act (DSCSA)* outlines steps to build an electronic, interoperable system to track and trace prescription drugs.[21] The original aim of the DSCSA was to enhance the ability of the FDA to regulate drug safety and help protect patients. However, this system could improve the management of drug product shortages as well.[22] Serialization (assignment of a unique serial number to each suppliable prescription product) in the drug supply chain could vastly improve an organization's ability to manage inventory. A pilot DSCSA program with the FDA showed the potential for using IBM blockchain technology to connect disparate data for tracking and tracing prescription medications and vaccines in the United States.[23]

In 2022, the NASEM published the congressionally mandated report, *Building Resilience into the Nation's Medical Product Supply Chains*. The report called for the FDA to track sourcing, quality, volume, and capacity information, and to establish a public database for health systems, inclusive of failure-to-supply penalties in contracts. In addition, the report recommended that the federal government optimize inventory stockpiling to respond to medical product shortages.[24]

While the federal government can generate greater economies of scale for the procurement of health care supplies during a pandemic, local governments can identify lower socioeconomic groups and minorities that are particularly vulnerable to both the health and economic aspects of a pandemic. As a result, they can employ resources more efficiently for a rise or fall in cases and hospitalizations.

ONSHORING AND NEARSHORING STRATEGIES

Concerns unleashed by the pandemic and dependence on foreign manufacturers combined to increase risks and raise doubts regarding "just-in-time" practices.[25] The disruptions caused by this approach have led to calls for greater domestic manufacturing capability through onshoring or reshoring (bringing production back to the United States) or nearshoring (bringing production back to friendly countries not far from the United States, such as Canada and Mexico). A European Parliament report found modest benefits to reshoring in the United Kingdom, United States and Japan and argued that reshoring should be primarily focused on specific critical sectors and products with pronounced supply bottlenecks, rather than across-the-board. Targeted reshoring was advised because host countries often do not have the production facilities and/or workforce required for wholesale reshoring.[26] Both onshoring and nearshoring should consider the ownership of the manufacturing: a foreign company can own domestic manufacturing facilities and still monopolize production.

One of the key areas affected by the pandemic was the API market. Research by McKinsey shows that supply chains in the pharmaceutical industry are more global than in other sectors, and there is a tendency to source certain materials from a particular region. For instance, 86% of the streptomycin in North America and 96% of the chloramphenicol in the European Union come from China. Diversifying supply chain materials is an option that pharmaceutical companies could pursue to reduce their exposure through onshoring. McKinsey estimates that 38% to 60% of the international pharmaceutical trade, worth $236 billion to $377 billion in 2018, could be considered for onshoring. Locally sourced API production will likely become an increasingly important part of government policy and pharmaceutical company commercial strategy. However, diversifying supply chains is expensive, and the cost of reconfiguring them will fall on consumers or governments. Further, the risk from regional domestic disasters in the vicinity of manufacturing and distribution facilities must be assessed.[27]

The United States once led the world in semiconductor manufacturing yet has fallen behind. Other countries, especially in Asia, made deliberate investments to build powerful chipmakers in their own countries. Foreign state subsidies created a ~30% cost advantage for foreign chipmaking plants, and the resulting advantage is startling: in 1990, the United States supplied 37% of the world's chips, but now only 11%. This outcome has undermined U.S. technology leadership with significant economic and national security implications: a recent White House study concluded that "our reliance on imported chips introduces new vulnerabilities into the critical semiconductor supply chain."[28]

In 2019, the U.S. medical end-use market accounted for $5.6 billion in total semiconductor sales— roughly 11% of the global industrial semiconductor market and 1.3% of the total semiconductor market. However, 47% of the chips sold worldwide are designed in the United States. Meanwhile, the medical semiconductor segment is growing faster than the overall industrial semiconductor market, which is driven by long-term trends of an aging population, the rise of telehealth, the move to portable and wearable devices, and the applications of artificial intelligence.[29] Despite being a small percentage of the overall semiconductor chip market, there is an urgent need for chips in medical device manufacturing.[30]

Recognition of chip vulnerabilities led Congress to pass and President Biden to sign the *CHIPS and Science Act* in August 2022. This law provides $52.7 billion in aid to the semiconductor industry along with other incentives to build new semiconductor production facilities in the United States.[31]

OPPORTUNITIES TO IMPROVE MEDICAL SUPPLY CHAIN PERFORMANCE

Since disruptions in medical supply chains have the potential to seriously impact patient care and safety, health care systems need the capacity to proactively foresee, absorb, and adapt to shocks and structural changes in a way that allows them to sustain required operations, resume optimal performance as quickly as possible, transform their structure and functions, and reduce their vulnerability to similar shocks and structural changes in the future.[32] Most experts agree that stakeholders must come together to develop consistent, meaningful metrics that reflect a sophisticated approach to managing and preventing shortages that pose risks to health care systems and patients.

There are several automated technologies available that health care systems can use to quickly access data and projections:

- Cloud-based, radio-frequency identification (RFID) technology allows for real-time tracking that prevents shortages while enabling health care professionals to view their inventory quickly and accurately.
- By tapping into the Internet of Things, internet-connected medical devices and equipment enable different systems in health care organizations to speak to one another and ensure information is updated across departments rather than being held up in siloes.
- A third option are analytics platforms, powered by artificial intelligence (AI), e.g., an electronic health record (EHR) embedded in an AI platform. On these platforms, cataloging allows users to distribute and curate all analytics in a single web-based action. Users may also have access to benchmarking data so they can analyze their overall performance.[33]

In a recent McKinsey survey of U.S. health system and supply chain executives, nearly three-quarters of survey respondents agreed that “the supply chain stands to assume an even more strategic role.” Three themes emerged as critical to a high-performing supply chain function:

- *Engage front-line physicians in supply decisions.* In high-performing organizations, physicians play an integral role in supply chain initiatives: they provide input on supplier selection and contracting strategies, including their financial impact; they support compliance with contract terms (for example, by committing to give a supplier a negotiated share of business); they manage the use of supplies; and they contribute to achieving financial, quality, or other goals.
- *Jointly set goals across facilities and functions.* Supply chain initiatives may require meaningful changes in behavior by some clinicians, including shifting away from their suppliers of choice to clinically similar suppliers used by their peers. To assist this change, systems may consider providing incentives, which can be financial or nonfinancial and may include a commitment to reinvest a percentage of savings in priorities of physicians.
- *Invest in accurate, actionable data and analytics.* Analytical tools are only useful if they provide relevant insights to their users, which may require individual customization and, for convenience, accessibility on multiple devices. For example, a supplies cost-per-case tool, which shows the cost of all supplies for a given operating-room procedure, should provide the relevant views for physicians so that they can see the supplies they use, cost compared to supplies used by peers, alternative supply options, and quality outcomes.[34]

At the 2019 Association for Health Care Resource & Materials Managementconference of the American Hospital Association, speakers emphasized eight points to strengthen relationships between physicians and PURE (Physicians Understanding, Respecting, and Engaging Supply Chain) professionals:

- *Share meaningful data with physicians*. Physicians are empiricists, motivated by data. As a result, health systems should provide meaningful data at a consistent cadence to physicians, perhaps quarterly.
- *Welcome partnerships in achieving the strategic goals of the organization*. Hospital systems that work with independent physicians should bring them into supply chain decision-making to include clinical perspectives.
- *Use evidence-based principles to guide decision making.*
- *Place some restriction on the number of vendors used.* However, be mindful not to limit physician preference items completely or force surgeons to use specific or substandard products.
- *Provide context for supply chain decision making.* Organizations should be very transparent regarding what relationships drive their supply chain decision-making, to include the use of group purchasing organizations (GPOs). Physicians understand economies of scale, price sensitivity and market trends, and want to play a role in finding solutions.
- *Include practicing physicians as part of the decision-making team*. Many hospital administrators do not have clinical backgrounds or currency, so it is important to have physicians with clinical experience on supply chain leadership teams. Physicians can share clinical insights to inform supply chain discussions, translate clinical and supply chain languages, and provide credibility for communication with physicians.
- *Update clinical pathways to include product categories that support evidence-based medicine and minimize clinical variation.* Data should be used to create algorithms and care pathways for high-volume procedures.
- *Emphasize that supply chain sustainment needs logisticians and physicians.* Collaboration is essential to anticipate and fulfill supply needs with timeliness and realism.[35]

FUTURE OF THE MEDICAL SUPPLY CHAIN: IMPROVED TECHNOLOGY AND PROCESSES, AND SITUATIONAL AWARENESS

While the pandemic caused major disruptions in health care with severe consequences, it also spurred medical and technological innovations. Telemedicine has become common, medical professionals have urged adoption of new models of care, shifting from cost-efficiency to long-term planning, and public-private partnerships have been formed to deal with current and future crises. One of the highest priorities for the medical supply chain is expansion, which includes more than the expansion of infrastructure and transportation in areas that have less accessibility. Patient care has historically been limited to a person's ability to arrive at a hospital or care facility and restricted by the supply chain's capacity to provide swiftly the correct product for that patient's individual need. Technology has recently enhanced treatment products to allow patients to receive care outside of a traditional care facility. A patient's treatment can now follow them outside of a hospital or medical practice with the use of telehealth communication, at-home testing kits, and at-home treatment that can be sent right to the patient's door. This requires the medical supply chain to extend past hospitals and include last-mile transportation to patients so that they do not have to return to the hospital. At-home patient care also requires more treatments to become personalized. The use of 3D printing and new forms of diagnostics allow for more personalized treatment to be provided while saving manufacturing costs.

As physicians and health care organizations adapt to newer data processing capabilities, they can more readily keep their information correct and consistent. Predictability is a must as we continue to move towards standardizing patient experience and more at-home care. The medical supply chain will need to implement strategies that help it become more predictable to physicians and health care organizations who need high visibility on their needed products. Currently, medical supply chain management lacks a unified, well-adopted data standard. The Global Trade Item Number (GTIN) standard is available, but adoption rates remain low compared to the universal product code (UPC) fully adopted in other industries. Clinical and regulatory requirements necessitate tracking of device information through the supply chain and in clinical EHR systems. Supply chain intermediaries bear responsibility for efficient supply chain integration.

Data will be utilized to anticipate product demand. Clean data will also help supply chains stay agile and not allow disruptions to hold up the services they are working to provide. Discontinued or back-ordered products can greatly disrupt a supply chain, though when such things can be more easily resolved with data analysis, the supply chain can become much more predictable. Data usage is one strategy that will help supply chain predictability, and several strategies can help a supply chain stay consistent and save costs. Some strategies for resilience include expanding domestic supply chain production, making product allocation needs-based, and increasing trust. The medical supply chain will have data that, if it is fully captured and analyzed, will be essential for decision making. Organized collection of data can greatly impact every stage of the supply chain, as each segment can make predictions based on past data and optimize processes.

Data can greatly enhance a company's capacity to be proactive, and predictive analytics can amplify that capability. Predictive analytics will help the supply chain with decision-making and offer a clear way to see the ebb and flow of supply and demand. Companies can use predictive analytics in new ways that help bring visibility to inventory and ensure the right products are being ordered and priced correctly and that there are enough items to meet demand. Predictive analytics can also help companies be more proactive in situations that significantly impact the medical supply chain. The COVID-19 pandemic created new aspects of health care to predict, like the number of COVID-19 cases, and the number of patients needing treatment. Predictive analytics can help companies prepare for these unforeseen circumstances and prepare the supply chain for future unknowns.

The use of artificial and augmented intelligence (AI) is growing throughout the health care industry: AI is being used to clean data and promote efficient human effort. There are even more ways that AI can be used to enhance health care and save costs. AI and predictive analytics—while being used nominally right now by physicians and health care organizations—can, should and will be used to ensure the right items, from the right sources, at the right prices for the right outcomes are ordered at the right times and in the right quantities to prevent shortages and price gouging. This will help to ensure financial stability of medical practices and health care organizations, while mitigating patient risk. AI can help supply chains keep up demand, by recommending stand-in products if the preferred product is not available. AI algorithms can be used to fill the gap between supply and demand while saving costs and eliminating human error.

Many health care organizations are addressing supply chain challenges with holistic solutions that pair technology with other changes. For the supply chain to function efficiently, physicians need to be involved in decision-making. Increasing supply chain resilience requires fostering an organization-wide commitment from leaders to staff members and by investing time and resources necessary to identify and address the root causes of supply chain challenges. Although technology is a crucial enabler of resilience through supply chain digitalization, using it as the tip of the spear to address weaknesses may only partially fix the issues. Comprehensive solutions that position technology as a component alongside people and processes can help make the medical supply chain more resilient. Several large health care organizations across the country have developed partnerships with shared goals and vision between physicians and hospital administrations. What is necessary to further these efforts is an investment in evidence tools and the creation of a physician role in the supply chain, which is becoming more common.

Some disruptions in a patient's care can be attributed to limited situational awareness between physicians and the supply chain. When physicians do not have knowledge of the products in the supply chain, they cannot provide the best treatment possible. When the supply chain lacks clear communication with physicians, medical practices, and health care facilities, it is difficult to know the demand for products and when they should arrive. The future of the medical supply chain entails transparent communication of supply chain issues and patient needs between suppliers and health care professionals. Supply chain professionals and physicians can work together to create methods that enhance situational awareness. Physicians can articulate needs, and medical supply chain professionals can provide information about the prices of products and transportation, outcomes, and alternative options for their products. Addressing these issues can improve the relationship between the supply chain and physicians and health care organizations. The medical supply chain can gain physician trust by communicating regularly and providing insight into the inner workings of logistics.

Adaptability and efficiency are crucial in today's health care supply chain environment. If a company's methods are too rigid, it will not be able to adapt quickly to unexpected changes. Furthering relationships between clinicians and suppliers will help a supply chain boost its robustness. Having trusting relationships between distributors and manufacturers, as well as effective contracting models, will create a strong network within the health care supply chain that can adapt smoothly while providing the most efficient services possible. Effective supply chain performance directly links to patient outcomes and clinical safety, influencing much more than PPE. Prior to the COVID epidemic, many physician leaders recognized the value of supply chain excellence; that value is now apparent to all physicians.

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