Accessibility of information. See Usability of information
Act phase of Plan-Do-Study-Act, 66–67
Ad hoc analytics, 25
Advanced analytics
applications of, 186–189
developing and testing, 190–197
overview, 183–186
See also Predictive analytics
Agents and alerts, 178–179
Aligning indicators
with data and processes, 122–123
with objectives, 124–125
Aligning processes with data, 94–95
Alternative hypotheses, 148
Analytical healthcare organizations
agility requirements for, 211–213
focus requirements for, 210–211
leadership and commitment
requirements for, 208–210
overview, 205–207
requirements overview, 207–208
strategy requirements for, 208
Analytical teams. See Team for healthcare analytics
Analytics
ad hoc, 25
beginning journey in, 11–13
documenting current state of, 47
embedded, 161–162
excellence in, 205
impact of, 6
knowledge gap in, 8–9
"push," 178–179
See also Advanced analytics; Analytics modeling process; Analytics strategy; Healthcare analytics; Predictive analytics
Analytic sandbox, 23
Analytics layer of analytics stack, 24–25
Analytics modeling process
choosing and implementing model, 195–196
deploying solution, 197
determining requirements of HCOs, 192–194
evaluating performance, 196–197
overview, 190–192
understanding and preparing data, 194–195
Analytics strategy
developing, 47–48
importance of, 208
purpose of, 26, 29–31
Analytics strategy framework
business and quality context, 34–35
overview, 32–34
processes and data, 39–41
stakeholders and users, 35–38
team and training, 43–45
technology and infrastructure, 45–47
tools and techniques, 41–43
Analyzing data
central tendency, 105–107
summarizing, 100–105
ANOVA (analysis of variance), 151–152
Artificial neural networks, 201
Audit data, 141
Averages (means), 106–107, 153
Balancing indicators, 126–127
Baseline performance, measurement of, 132–136
Big data, as relative term, 9
Bimodal distributions, 105
Blaming, culture of, 136–137
Box-and-whisker plots, 109–110
Bullet charts, 175
Business and quality context of analytics strategy, 34–35
Business context layer of analytics stack, 23
Business intelligence (BI) stack, 21–22
Business intelligence (BI) strategy and analytics strategy, 26, 30
Business intelligence (BI) suites, 180
Business intelligence (BI) systems, 10, 205
Business processes
in analytics strategy, 41
presenting data in context of, 93
Business rules, 78
Canadian c-spine rule, 193
Canadian Institute for Health Information, dimensions of data quality, 79, 80
Categorical (nominal) data, 98, 99, 152
Centerline of control charts, 155–156
Central tendency, 105–107
Change
  analytics team involvement in, 83–84, 86–87
  measuring and evaluating impact of, 141–143
  resistance to, 206
  sustaining, 143
Charts
  box-and-whisker plots, 109–110
  bullet, 175
  design and usability of, 171–173
  histograms, 103–105, 108–109
  Pareto, 137–138
  scatter plots, 110–111
  See also Statistical process control (SPC) charts
Classification data, 95–96
Classification type of predictive model, 190
Clinical concerns and improvement projects, 131
Clinical decision support, 20, 186
Cloud computing, 46
Commitment to analytics strategy, 208–211
Common cause variation, 153–154
Computerized provider order entry systems, 20
Confidence intervals, 150
Continuous data, 95–96
Control charts, 153. See also Statistical process control (SPC) charts
Control limits, 154–155
Costs
  of healthcare, 4–5
  of improvement efforts, 136
  prioritizing goals based on, 132
  value in relation to, 53–54
Count data, 95–96
Counting data, 102
Cross Industry Standard Process for Data Mining (CRISP-DM), 191
Customers
  as stakeholders, 36–37
  value defined in relation to, 53
Dashboards
  design of, 176–178
  indicators and, 119–120, 175–177
  overview, 11, 173–176
  real-time, 17–18
  sample, 161, 174
usefulness of, 162
visualization techniques in, 101
Data
  aligning indicators with, 122–123
  in analytics strategy, 39–41
  audit, 141
  availability of, 78, 81
  in decision making, 16
  electronic storage of, 96–97
  errors in, 82–83
  manual collection of, 65, 134
  ownership of, 88–89
  periodicity of, 78
  predictive analytics and, 187–188
  preparing for analytics, 92–99
  presenting, 107–112
  privacy and security of, 77–78
  as raw material of analytics, 92
  for SPC charts, 156–157
  types of, 95–99
  See also Data quality; Data sources; Data visualization; Working with data
Data discovery, 185
Data governance, 39–41, 84–87
Data layer of analytics stack, 23–24
Data management, 2, 39–41, 75–78
Data marts, 23–24
Data mining, 25, 185–186
Data modeling, 75–76
Data overload, risk of, 2
Data profiling tools, 42
Data quality
  baseline performance, 134
  improving, 79–84
  processes and, 39–41
  requirements for, 77, 78–79
Data sources
  baseline performance, 134
  described, 23
  multiple, 83
  processes and, 39
  quality of, 81, 82
Data stewardship, 87–89
Data storage, 23, 76, 96–97
Data visualization
  overview, 165–166
  types of message and selection of, 169–172
  uses of, 167–169
  See also Dashboards
Data warehouses, 23
Decision making, 10–11, 15–19
Decision trees, 201
Define, measure, analyze, improve, and control (DMAIC) methodology, 71–73
Dependent t-tests, 149
Dependent variables, 198
Deploying predictive analytics solutions, 197
Descriptive statistics, 146
Development, strategic, compared to “by aggregation,” 32
Distrust of information, 206
DMAIC (define, measure, analyze, improve, and control) methodology, 71–73
Documentation on portals, 181
Documenting current state of analytics, 47
Do phase of Plan-Do-Study-Act, 65–66
Drucker, Peter, 7
Effort, estimating, 138–139
Electronic data warehouses, 23
Electronic medical records (EMRs), 2, 76–77, 186
Electronic storage of data, 96–97
Embedded analytics, 161–162
Errors
data, 82–83
medical, 3
ETL (Extraction/Transformation/Load) process, 24, 46
Evaluation of predictive analytics model, 196–197
Evaluation phase, 141–143
Evaluation strategy, 25
Executing analytics strategy, 48
Execution excellence, 207
Experimentation, 140
Extraction/Transformation/Load (ETL) process, 24, 46
Few, Stephen, 174, 177
Financial concerns and improvement projects, 131
Fishbone diagrams, 137
Forrester Research, Inc., 21
Fraud prevention, 20–21, 186
Frequency distributions, 102–103
F-statistic, 151

General Electric, 71
Goals
prioritizing, 131–132
strategic, 124, 211
tactical, 124–125
Graphical methods, 153, 160–162. See also Charts; Statistical process control (SPC) charts
Gross domestic product and healthcare expenditures, 4–5
Grove, Andy, 4

HCOs. See Healthcare organizations
Healthcare analytics
applications of, 19–21
benefits of, 61
components of, 12–13, 21–26
defined, 5
effectiveness of, 160–162
fundamental objective of, 16
as lagging other industries, 6
overview, 215–216
preparing data for, 92–99
quality, performance, and, 17–19
See also Advanced analytics; Leveraging analytics; Predictive analytics; Team for healthcare analytics
Healthcare organizations (HCOs)
beginning analytics journey in, 11–13
challenges facing, 3–4, 7, 34–35
as data-centered, 9–10
failure of QI projects in, 6–7
operating environment of, 59
as struggling, 1
types of, 55
See also Analytical healthcare organizations
Health information technology (HIT)
adoption of, 76–77
defined, 7
infrastructure for, 45–47
leveraging, 7–8
management of data generated via, 2
potential of, 1
process data examples, 57
tug-of-war between business side and, 32–33
Histograms, 103–105, 108–109
HIT. See Health information technology
Hypothesis testing, 147–148
Identifying
gaps in analytics, 48
improvement opportunities, 136–139
Impact/effort grids, 138–139
Impact of changes, measuring and evaluating, 141–143
Improvement strategy, 25
Improving systems
identifying opportunities for, 136–139
outcomes, 58
overview, 55–56, 59
process, 57
structure, 56–57
See also Performance improvement; Quality improvement
Independent t-tests, 149
Independent variables, 198
Indicators
aligning with data and processes, 122–123
analytics teams and development of, 116
baseline performance, 134
dashboards and, 119–120, 175–177
defined, 25, 118–119
as guiding improvement activities, 123–125
key performance indicators, 120–122
lagging, 59
levels of, 140–141
of patient outcomes, 126–127, 142
published sets of, 58
selecting, 125–127
Inferential statistics, 146–147
Influencers, as stakeholders, 37
Information, as guiding improvement activities, 60–61, 160–162. See also Usability of information
Information technology (IT)
defined, 7
leveraging for healthcare improvement, 9–11
ROI on projects, 143–144
See also Health information technology
Information value chain, 92
Infrastructure requirements for healthcare analytics, 45–47
Innovation, rewarding, 209
Insight
embedding in dashboards and reports, 161
moving to improvement from, 129–132
Institute of Medicine
definition of quality, 52
To Err Is Human report, 3
Integration
of EDWs, 24
of quality and analytics teams, 215
Interval data, 98–99
Ishikawa diagrams, 137
IT. See Health information technology; Information technology
Juran, Joseph, 79
Key performance indicators, 120–122
Knowledge and discovery layer of infrastructure, 46
Levels of measurement and data types, 97–98
Leveraging
health information technology, 7–8
information for QI, 9–11
Leveraging analytics
in evaluation phase, 141–143
in execution stage, 140–141
in identification phase, 136–139
in moving from insight to improvement, 129–132
overview, 129
in problem definition phase, 132–136
in sustaining improvements phase, 143
Loose coupling of data, 46
Lower control limits, 155–156
Machine learning, 200–202
Manual collection of data, 65, 134
Means (averages), 106–107, 153
Measurement
of baseline performance, 132–136
of impact of changes, 141–143
levels of, and data types, 97–98
Measures, defined, 116–117
Medians, 106, 107
Medical errors, 3
Metrics, defined, 117–118
Modes, 106
Monitoring, real-time, 17–18
Motorola, 71
Networks, 46
Nominal (categorical) data, 98, 99, 152
Non-value-added activities, 53, 54–55
Null hypotheses, 148
One-sample t-tests, 149
Online analytical processing, 24
Operational data stores, 23
Ordinal data, 98, 99, 152
Organizing portals, 181
Outcome indicators, 126–127, 142
Outcomes
evaluating, 141–143
of healthcare, 58
value measured in relation to, 54
Outliers, 106–107, 109
Overfitting, 196–197
Ownership of data, 88–89
Parameters, defined, 101
Pareto charts, 137–138
Parmenter, David, 120
Patients
focus on experience of, 60
outcome indicators and, 126–127
as stakeholders, 36
value to, 142
Pattern recognition, 200
Payer risk analysis, 20–21
Paying for healthcare services, 53
Percentiles, 107
Performance
  of analytical tools, 78
  causes of variation in, 153–155
Performance improvement
  analytics strategy and, 31
  decision making for, 17–19
  See also Quality improvement
Physical layer of infrastructure, 46
Physical storage, 46
Plan-Do-Study-Act (PSDA), 63–67
Plan phase of Plan-Do-Study-Act, 64–65
Population, defined, 100
Population health management, 20, 186
Portals, BI or analytics, 180–181
Porter, Michael, 53, 54
Predictive analytics
  data mining compared to, 185–186
  described, 25, 184, 197–198
  enablers of, 187–189
  machine learning and pattern recognition, 200–202
  regression modeling, 198–200
  See also Advanced analytics
Preparing data for analytics
  aligning processes with data, 94–95
  overview, 92–93
  types of data, 95–99
  understanding what data represents, 93–94
Presentation and visualization of information. See Charts; Data visualization
Presentation layer of analytics stack, 25–26
Presenting data, 107–112
Prioritizing
  goals, 131–132
  projects, 138–139
Privacy of data, 77–78
Problem definition phase, 132–136
Processes
  aligning with data, 94–95, 122–123
  in analytics strategy, 39–41
  changing, analytics team involvement in, 83–84, 86–87
  data out of sync with, 82
  defined, 25
  of healthcare, 57
  stable, 154, 157–159
  See also Business processes
Process indicators, 126–127
Professional development and training, 43–45
Professional excellence, 206–207
Project execution phase, 140–141
“Push” analytics, 178–179
P-values, 150
QI. See Quality improvement
Qualitative data, 95
Quality
  defined, 51–52
  of healthcare, 1, 3–4
  See also Data quality
Quality and performance layer of analytics stack, 25
Quality improvement (QI)
  analytics knowledge gap and, 8–9
  analytics strategy and, 31
  decision making for, 17–19
  failure of projects, 6–7
  frameworks for, 2, 61–63
  gaining maximum value from analytics, 130
  information as guiding, 60–61
  integrating quality and analytics teams, 215
  Lean methodology, 67–70
  leveraging HIT for, 7–8
  leveraging information for, 9–11
  overview, 59–60
  phases of, 130
  Plan-Do-Study-Act, 63–67
  processes and workflows, 19–20
  Six Sigma, 71–73
  systematic methodologies for, 60, 73
Quantitative data, 95
R (open-source tool), 42
Radio frequency identification devices, 2
Ratio data, 98–99
Reactionary activities, 210
Real-time data systems, 179
Real-time monitoring, 17–18
Regression modeling, 190, 198–200
Regulatory concerns and improvement projects, 131–132
Reports
  baseline data, 135–136
  reducing and consolidating, 181
  types of, 10
Return on investment (ROI), 143–144
Robust decision-making models, 16–17
Root causes of problems, determining, 136–137, 192
Runtime, minimizing, 181
Samples, defined, 100
Satisfaction, value measured in relation to, 54
Scalability, 47
Scatter plots, 110–111
Security of data, 77–78
Servers, 46
Six Sigma methodology, 63, 71–73, 146
Skill sets for healthcare analytics professionals, 44
SMART acronym for developing indicators, 121–122
Software with predictive analytics capability, 188–189
Sparklines, 175
SPC (statistical process control), 154–155
SPC charts. See Statistical process control (SPC) charts
Special cause variation, 154
Specification limits, 159
Sponsors, as stakeholders, 36
Stable processes, 154, 157–159
Stakeholders, 35–38
Statistical learning, 197–198
Statistical methods
  challenges with, 153
  comparison between two groups, 148–150
  comparison of multiple groups, 151–152
  hypothesis testing, 147–148
  machine learning compared to, 200
  overview, 145–147
  predictive analytics and, 187
  using with graphical methods, 160–162
Statistical process control (SPC), 154–155
Statistical process control (SPC) charts
  data considerations, 156–157
  as data visualization, 166–167
  displaying stability of processes, 157–159
  overview, 155–156, 157
  types of, 159–160
Statistical significance, tests of, 147–148, 150
Statistical tools, 42
Statistics
  defined, 101
  descriptive, 146
  inferential, 146–147
  See also Statistical methods
Strategic activities, 210
Strategic goals, 124, 211
Strategy, defined, 30
Structure of healthcare, 56–57
Study phase of Plan-Do-Study-Act, 66
Summarizing data, 100–105
Support vector machines, 201
Sustaining changes and improvements, 143
Systems
  defined, 55
  predictive analytics and, 188–189
  See also Improving systems
Tactical activities, 210
Tactical goals, 124–125
Targets, defined, 25
Team for healthcare analytics
  building effective, 213–215
  changing processes, involvement in, 83–84, 86–87
  focus of, 210–211
  integrating with quality team, 215
  training for, 43–45
Technical excellence, 206
Technology requirements for healthcare analytics, 45–47
Terminology, use of, 13
Testing predictive analytics models, 196–197
Text mining, 25, 186
Time period for baseline performance data, 134
To Err Is Human report (Institute of Medicine), 3
Tools and techniques of analytics strategy, 41–43
Toyota Production System (Lean methodology), 67–70
Training and professional development, 43–45
T-tests, 148–150, 151
Two-sample t-tests, 149
United Kingdom, National Health Service QI framework, 63–67
Upper control limits, 155–156
Usability of information dashboards, 173–179
  ensuring, 180–181
  presentation and visualization, 165–173
User interface design, 82, 180–181
Users
  analytics strategy and, 35–38
  design of dashboards and, 177
Value
  defined, 53–55
  generated through analytics, 144
  to patients, 142
Value stream maps, 68, 69
Variables, dependent and independent, 198
Variation in performance, causes of, 153–155
Visualization tools, 42. See also Charts; Data visualization
Working with data
  avoiding rookie mistakes, 91
  central tendency, 105–107
  preparing data for analytics, 92–99
  presenting data, 107–112
  summarizing, 100–105
Yau, Nathan, 166