

# Information and cognitive overload

## How much is too much?

Richard L. Byyny, MD

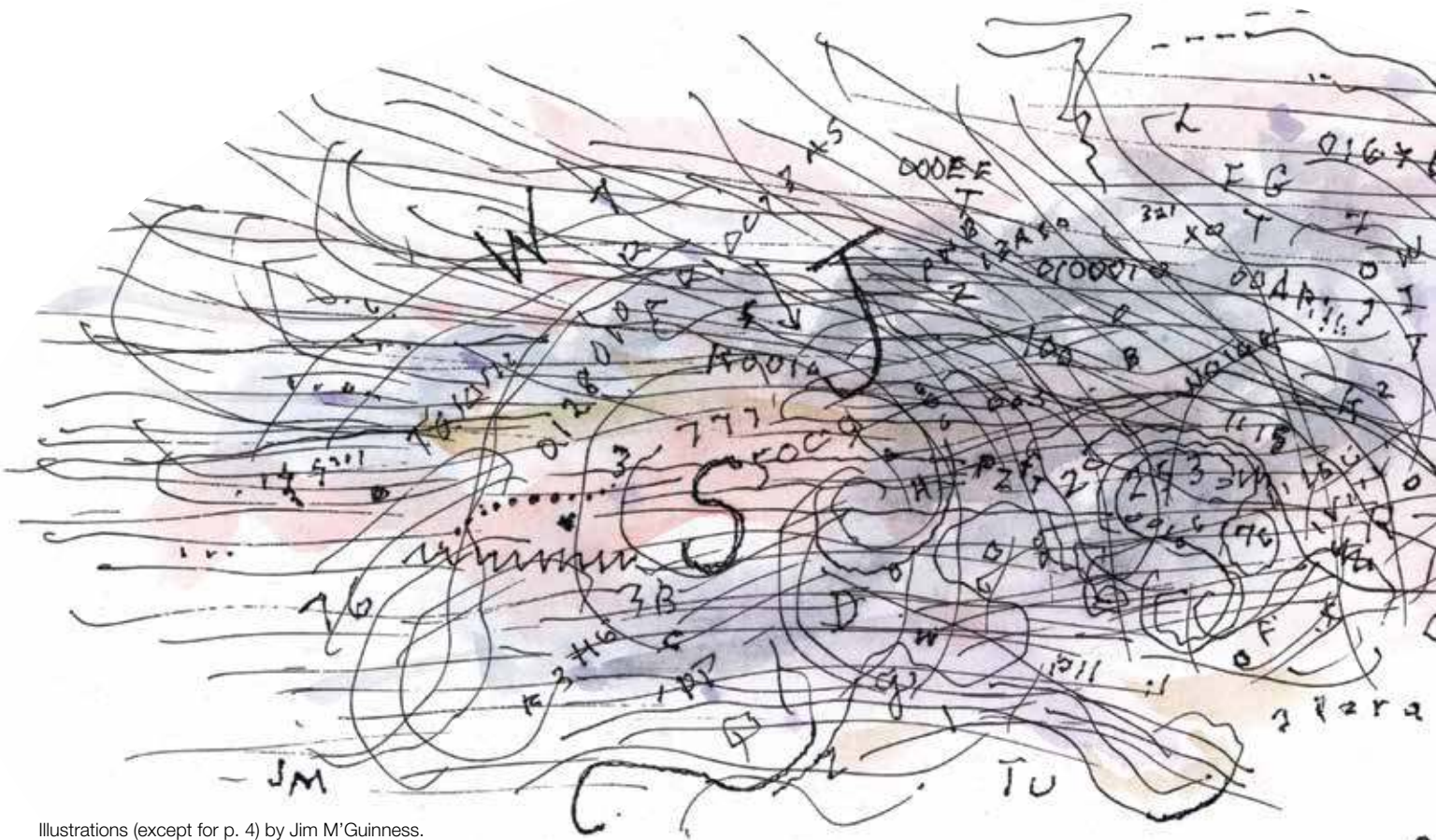
We are in an age of information overload. The Internet, e-mails, apps, spam, tweets, social media, texting, Facebook, Instagram, memes, news feeds, online videos, updates, and myriad other forms of information have significantly increased the information directed at us, as well as those in which we request to participate.

We have come to regard this overload of information, and brain drain, as the norm. We accept this inundation as communication, learning, practice, performance, social and professional interaction, and decision-making, without ever considering our well-being, productivity, and sanity.

A 2012 survey found that average workers spend 28% of their time managing e-mail,<sup>1</sup> and a British study found we check our phones on average 221 times a day, or about every 4.3 minutes.<sup>2</sup> A Stanford University School of Medicine team found that nearly one in eight Americans exhibit problematic Internet use.<sup>3</sup>

In 2009, 50 billion e-mails were sent each day. In 2010, that number rose to 294 billion e-mails per day.

Social norms have introduced a presumed requirement to participate, and collaborate, in every message we receive. In contrast to the continuous growth in technology and information, our human capabilities are limited.



Illustrations (except for p. 4) by Jim M'Guinness.

Our neurons don't increase in numbers, nor do they respond more quickly to this overdose of information. Our memory does not increase in capacity. We do not learn or think faster, and this mismatch creates, contributes to, and causes information, participation, and collaboration overload. The effort required to keep track of, and participate in, what is going on professionally, with family and friends, and in the world requires an ever-increasing amount of attention and time.

We are continuously distracted from important priorities—thinking, learning, reflecting, decision-making. The presentation of information has become an insidious influence in the loss of our intellectual independence. We are bombarded with jibber-jabber, rumor, and opinions that are often biased with inaccurate or false information.

In the days of Walter Cronkite, there were only a few sources of information, and each had important filters — journalistic reviews, peer reviews in journals, and fact checkers—that reviewed the information and verified its accuracy before it was presented publicly. With today's 24/7 communication environment, it's about posting it on the Internet first, and fact checking later.

Information is often presented by self-claimed experts, colleagues, and a multitude of journalistic-like outlets. Many media specialists, bloggers, podcasters, and others have no professional training or background in journalism, professionally-mandated ethics, or communication.

We should wonder if what we are reading or hearing is valid

and substantiated. Many so-called experts are more interested in serving their own egos, and enhancing their reputations than actually providing valuable information and knowledge. Unfortunately, based on their biases, they presume that they know what we should know, and think they know better than we know ourselves.

From a social perspective, this is compounded by a herd mentality that can characterize and influence the story and information over time. As a society, we have come to let people we don't know, and who are not always qualified, to decide what we need to know and when we need to know it. This creates an unintended consequence of impeding knowledge and learning.

Increasingly, more people are becoming addicted to the plethora of information on the Internet, which can result in compulsive pursuits without any thought process. There is unsolicited information, task-relevant information, well-known information, vaguely known information, and information based on belief and opinion. It takes an inordinate amount of time and attention to participate in the preponderance of available sources of information.

Information must be filtered and considered in the context of the user—not the disseminator. It should be filtered for substance, significance, reliability, and completeness. Our critical thinking should make us wary to completely trust what we read on the Internet. As Gerhard Fischer wrote, "We should focus on our need for the right information, at the right time, in the right place, in the right way, to the right person."<sup>4</sup>

Information overload is compounded by the accompanying participation overload, which consumes time, attention, and brain power. It creates a poverty of attention.

### Cognitive overload

Cognitive load is the amount of mental effort being utilized in working memory at any given time. Human





memory is limited in its capacity to effectively utilize and learn from cognitive input. Cognitive psychologists and scientists often categorize memory into three primary subsystems—sensory, working, and long-term memory.

Sensory memory perceives, and briefly retains, visual and auditory information. Sensory information is stored long enough to be transferred and utilized in short-term memory allowing for the retention of impressions of sensory information, after the original stimulus has been processed.

Working memory is constrained by a small storage capacity. It is vital to learning, and performing tasks. Working memory retrieves relevant knowledge possessed and stored by the learner in long-term memory. It organizes the new with the existing information to facilitate efficient storage of the new information in a modified schema.

In a seminal paper in 1956, George Miller, Princeton University, demonstrated that most individuals can only hold seven +/- two units of information in working memory at any given time, and can organize, compare, and contrast no more than two to four elements at any given time.<sup>5</sup> That means working memory is very limited in capacity, which creates an inherent constraint on our ability to process and store information in long-term memory.

Long-term memory has nearly unlimited storage. Retrieving information is constrained by use rather than limits on capacity.

In order for information to be used and applied it must be stored in long-term memory and be recalled and applied when necessary. Memory retains and stores information learned into file drawers or schemas of accessible learned information. We retrieve the information using retrieval cues to open the right drawers, and transfer that information into working memory. The long-term schemas give rise to expertise.

Cognitive load has also been categorized as intrinsic load, which depends on the number and complexity of information elements, and the interaction of the elements in the learner's knowledge—the load associated with the task.

Extraneous load is not essential to the task, but induced by design of the task, and how information is presented in the environment. It includes thoughts about non-emergent and unimportant work items—social media, transient digital information, etc.

Germane load is devoted to the processing, construction and automation of schemas in working memory so they can be integrated into existing knowledge and long-term memory, and retrieved and used for problem solving and decision-making.

Dr. Jerome Kassirer (AQA, Jacobs School of

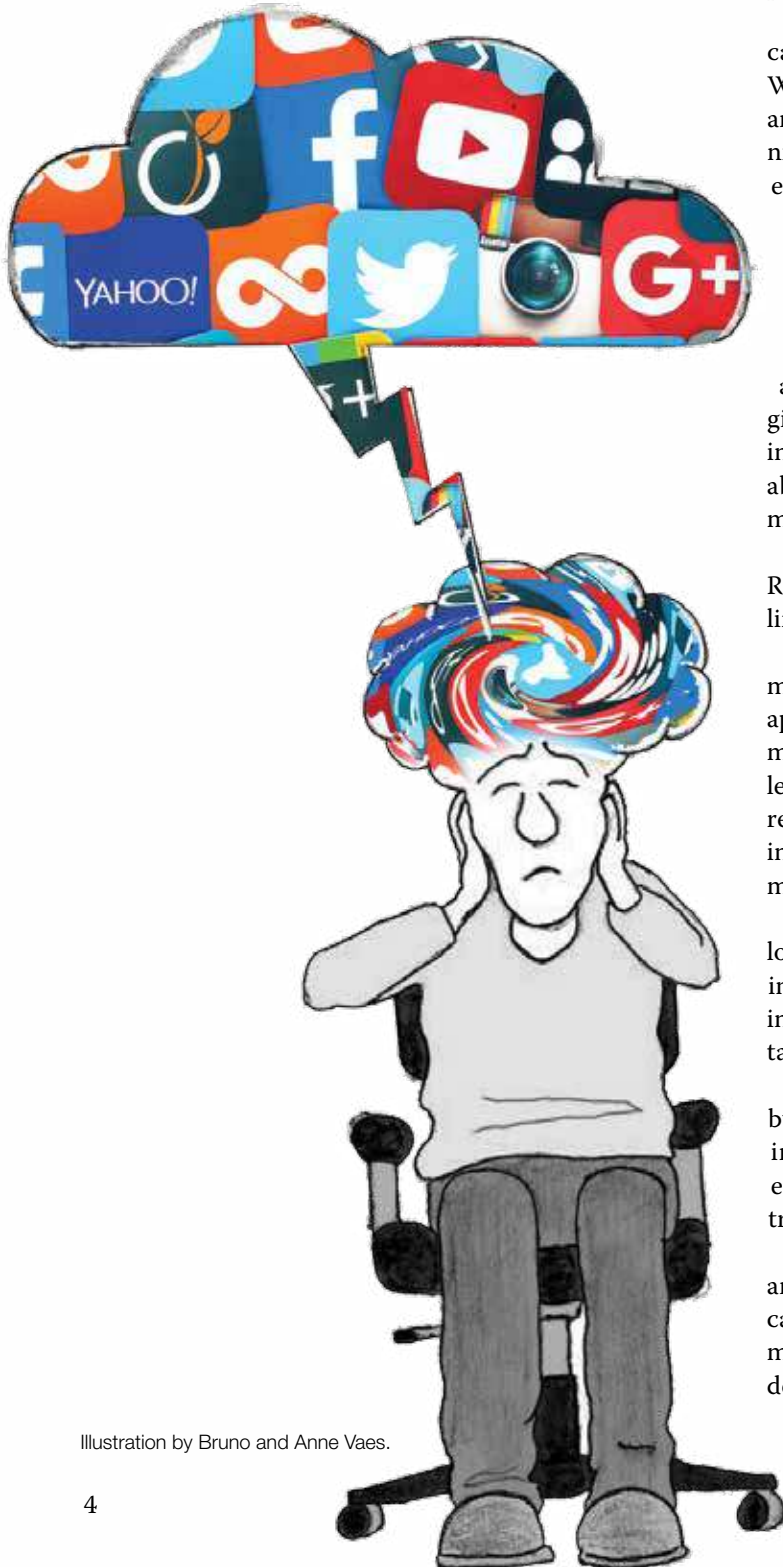


Illustration by Bruno and Anne Vaes.

Medicine and Biomedical Sciences at the University of Buffalo, 1956) found that, “to develop expertise in problem-solving and decision-making, it is not enough to learn how to find information. We also need to remember the information and know how to use it.”<sup>6</sup> Cognitive learning theory is based on understanding and diverting cognitive processing power toward germane cognitive load.

We have a harder time learning new things when our brains are distracted. This is also complicated when inaccurate information is stored for retrieval into working memory, resulting in faulty reasoning and decision-making ability.

### Multi-tasking is not all it's cracked up to be

Information overload is also related to multi-tasking. Many people take great pride in being a multi-tasker, and see multi-tasking as an accomplished skill. However, evidence indicates that multi-tasking does not improve work, decision-making, or productivity, but it does contribute to cognitive overload and its associated consequences.

The average young adult moves between media platforms 27 times per hour, which can lower IQ by as much as 15 points.<sup>7</sup> As a contrast, studies that have shown an eight percent decrease in IQ for regular marijuana smokers who used heavily from adolescence onward.<sup>8</sup>

Multi-tasking adversely affects emotional intelligence, and cognitive functions. We know that the brain cannot pay attention and process more than one thing at a time, but multi-tasking requires rapid and repeated switching of attention from one thing to another, and back again. This results in ignoring important information, faulty or incorrect reasoning, and slower completion of tasks that are done less well than if done one at a time with a thoughtful approach.

Multi-tasking creates decreased attention span, a state of inaction, and negatively impacts the ability to make smart decisions. It adversely affects work performance, and the time to get the task done, thereby limiting innovation, ingenuity, and creative thinking.

It has been shown that it takes an average of 25 minutes to return to a work task after an e-mail interruption, and workers who completed the same tasks in parallel took 30% longer and made twice as many errors as those who completed tasks sequentially.<sup>9</sup>



We are also increasingly burdened by just-in-case learning rather than just-in-time learning. Studies on heavy media multi-taskers compared to light media multi-taskers found that heavy media multi-taskers have a reduced ability to filter out interference from irrelevant information, and they are more likely to pay attention to a large scope of information rather than focusing on any particular piece of information. Heavy multi-taskers are less selective in filtering information and tasks they should attend to, and accomplish, in a defined time period. They are more likely to interpret all information as equal, or nearly equal, in importance. In addition, it is harder to learn and remember new important information when frequently distracted by many activities.<sup>10</sup>

Chronic multi-tasking is rapidly becoming nearly ubiquitous, creating challenges and adversely affecting human cognition, thinking, and learning.

### New disorders

Neuroscientists and psychologists have identified new maladaptive behaviors including Internet Addiction Disorder (IAD), Problematic Internet Use (PIU), and Addiction Deficit Disorder (ADD).<sup>3</sup> The layperson may know this as Information Fatigue Syndrome, but it can, and often does, evolve into a full-blown disorder.

Although the definitions and criteria lack standardization, and are not yet recognized in DSM-5 as psychological disorders, they do seem to be part of a continuum of technology addiction. Due to the prevalence, and potential adverse effects and outcomes, it appears to be analogous to other compulsive use disorders.



Officially named disorder, or not, excessive involvement and use of information technology and social media can have serious effects, affect memory, and influence everyday life. It is still unknown how much use and involvement is too much to cause adverse emotional, functional, and health outcomes.

What can, and should, we do about this new and increasing phenomenon? Let's start with increasing awareness of the problematic side of information and cognitive overload. As physicians, teachers, educators, and writers, we strive to contribute to others' learning about new things, including unintended adverse consequences.

As physicians, it is our job to understand and influence

harmful behaviors, and support positive change. We have patients who can benefit from changing their perceptions, attitudes and regimen with regard to Internet and social media use. We have family, friends, colleagues, and are a member of organizations where our awareness and knowledge can be of benefit to those suffering from information and cognitive overload.

In 1967, Peter Drucker noted in “The Effective Executive” that effectiveness in accomplishing tasks requires a focus of attention on one problem at a time, and devotion of the time needed to complete the task.<sup>11</sup> In our profession, we have developed task and time management approaches and strategies, but often by habit rather than thoughtful planning. We also know that some approaches work better than others.

We need to respond and adapt to behavioral changes, and modify our thinking and behaviors. We can do things differently, make changes, better manage our time, and reduce interruption and unanticipated distractions.

Developing a time management protocol requires a modest investment and focus for one week to analyze current time use. By keeping an hourly time log for a typical week, with all hours and activities logged, including sleep and non-work-related activities recorded, we can determine how, when, where, and why we spend our time. At the end of the assessment week, time should be subclassified into categories, e.g. medicine, education, meetings, idle/wasted, family, etc. This helps determine changes that can be initiated to better manage time.

The next step is to set personal goals categorized by interest, necessity, work, education, health, etc. This will develop an awareness of requirements, electives, unnecessary activities, and others, to create a plan to make effective changes.

After personal goals comes daily goals, also categorized by what can be achieved each day, then prioritized. Goals that are achieved are checked off. Strategies to achieve goals and eliminate time-wasting activities will become apparent, and the ability to take control through choices will become achievable.

Time is our greatest asset and must be used wisely. Parkinson’s Law states that there is a human tendency to spend effort and time on more insignificant tasks that are perceived as important rather than on those of true importance. For example, Dr. Pete Reynolds, one of my mentors and professors, felt compelled to keep up his continuing education, but found difficulty in pursuing his education because of constant interruptions. When on rounds, he had a notebook in which he would record questions that he or

others couldn’t answer when asked. Every Thursday night, his family knew that he would be away studying, and not home for dinner. He would go to the county medical association library, because he wouldn’t know anyone there who might disrupt his attention and concentration. He would research the questions he had written down in his notebook. Upon leaving, he would tear up the list of notes, and start over for the next week. He was the smartest and best informed of any of my teachers, mentors, and colleagues.

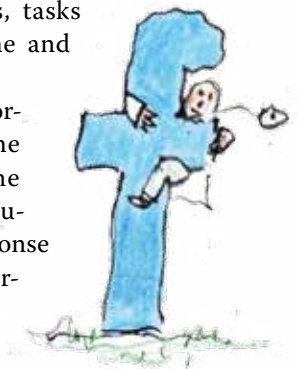
As another example, when I started my first job as a faculty clinician, I had an open door policy in my non-clinical office. I was repeatedly interrupted by almost anyone for almost anything, and couldn’t complete tasks, study and write. I obtained a study carrel in the university library, and scheduled time on my calendar to be away for a half day each week. I didn’t carry a beeper during those times, and wouldn’t have carried my cellphone if I had one. No interruptions, and my productivity soared. I found that the problems that were waiting for my return had usually been solved without my input.

Time management strategies include setting short- and long-term goals; setting priorities for responsibilities; planning and organizing activities; and minimizing activities that waste time. It is more about behaviors than time; and matching time with priorities and goals. Time management takes time to learn, practice, and master.

Effective time management is one of the most important competencies for physicians. We must learn to say no in a professional and justifiable way. We must learn to delegate, and minimize interruptions and distractions. We should schedule time on our calendars—professional and private—for our predetermined priorities and important tasks.

Stephen Covey’s “7 Habits of Highly Effective People” provides Covey’s Time Management Grid (see illustration).<sup>12</sup> The grid is used to manage information and responsibilities into classifications: urgent; non-urgent; important; and not important. Quadrant I is urgent and important for the immediate and imperative deadlines. Quadrant II is non-urgent and important for long-term strategizing, priorities, tasks and responsibilities that require time and attention.

Quadrant III is urgent and not important. It represents unimportant time pressured distractions, but someone wants it now or soon creating an illusion of importance and a stress response mentally with an adrenergic/dopaminergic reaction (many information and





	URGENT	NOT URGENT
IMPORTANT	<b>Quadrant I:</b> Urgent & Important	<b>Quadrant II:</b> Not Urgent & Important
NOT IMPORTANT	<b>Quadrant III:</b> Urgent & Not Important	<b>Quadrant IV:</b> Not Urgent & Not Important

From Steve Covey's *7 Habits of Highly Effective People*.

cognitive distractions fall into this quadrant).

Quadrant IV is not urgent and not important for activities that have little or no value, but are often used for taking a break or distraction from other important activities.

Most activities fall into Quadrants I and III, while Quadrant II is most important because one must work with attention and allocated time to accomplish the task. The lesson here is to quit spending time and attention on unimportant tasks and activities, and do the important things first.

### Improving our well-being

Information and cognitive overload lead to a loss of control over much of our professional and personal lives. This creates undo stress and unimportant distractions which may adversely affect our work and lives and contribute to professional dissatisfaction and burn out. A thoughtful understanding of this problem, and implementing effective approaches and strategies can help to regain control of many, if not most, responsibilities, work, and other activities.

We are exposed to too much unimportant information that leads to cognitive overload. We are depleting our brain power with babble, drivel, foolishness, gibberish, and balderdash. The expectation that we will participate and respond to copious unimportant sources of information is unreasonable and impracticable. We must become experts at managing our time, expectations, and the influx of information that we seek out, and in turn, seeks us out. If we recognize and understand this new intrinsic element of the modern era, we can adapt, make behavioral changes, regain control, and improve our professional roles, personal and professional lives, and our overall well-being.

### References

1. Sunshine J. Workers Spend One-Fourth of Workday Reading, Responding To Email: Survey. Huffington Post. 2012 Aug 1. [http://www.huffingtonpost.com/2012/08/01/email-workday\\_n\\_1725728.html](http://www.huffingtonpost.com/2012/08/01/email-workday_n_1725728.html).
2. Rucki A. Average smartphone user checks device 221 times a day, according to research. EveningStandard. 2014 Oct 7. <http://www.standard.co.uk/news/techandgadgets/average-smartphone-user-checks-device-221-times-a-day-according-to-research-9780810.html>.
3. Young KS. CBT-IA: The First Treatment Model for Internet Addiction. *J Cog Psychotherapy*. 2011;25(4): 304–311.
4. Fischer G. BMBF Report: Conceptual Frameworks and Innovative Computational Environments In Support Of Self-Directed and Lifelong Learning. <http://l3d.cs.colorado.edu/~gerhard/reports/bmbf1998.pdf>.
5. Miller GA. The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information. *The Psychological Review*. 1956;63: 81–97.
6. Kassirer JP, Kuipers BJ, Gorry GA. Toward a theory of clinical expertise. *Amer J of Med*. 1982 Aug;73(2): 251–9.
7. Mohan I. Multi-tasking millennials are costing us billions. *Boston Globe*. 2016 Aug 16. <https://www.bostonglobe.com/business/2016/08/16/multi-tasking-millennials-are-costing-billions/agi6ig1C2DaEM15V2FeIAI/story.html>.
8. Bebinger M. As More States Consider Legalizing, Questions About Pot And The Brain. *National Public Radio*. 2016 Sept 13. <http://www.npr.org/sections/health-shots/2016/09/13/492814117/as-more-states-consider-legalizing-questions-about-pot-and-the-brain>.
9. Wong K. How Long It Takes to Get Back on Track After a Distraction. *lifehacker*. 2015 Jul 29. <http://lifehacker.com/how-long-it-takes-to-get-back-on-track-after-a-distraction-1720708353>.
10. Ophir E, Nass C, Wagner AD. Cognitive control in media multitaskers. *Proc Natl Acad Sci U S A*. 2009 Sept 15; 106(37): 15583–7.
11. Drucker PF. *The Effective Executive: The Definitive Guide to Getting the Right Things Done*. New York:HarperBusiness; 2006.
12. Covey SR. *7 Habits of Highly Effective People*. New York:Free Press; 1989.