Medical Hypotheses (1999) **53**(4), 338–344

Article No. mehy.1998.0777

Alfred Nobel's unusual creativity: an analysis

S. Sri Kantha

Fukuroi City, Shizuoka, Japan

Summary Howard Gardner identified five different kinds of creative activity among eminent creators, namely, solving a well-defined problem, putting forth a general conceptual scheme, creating a product that embodies ideas, stylized innovation of an art form, and a 'high-stakes' performance in the socio-political arena. In this paper, I report that Alfred Nobel's creativity can be assigned to two mutually exclusive domains. In the scientific domain, he solved a well-defined problem of his time in the study of explosives, by patenting dynamite, creating blasting gelatin as an ideal explosive and developing a nearly smokeless blasting powder. In the socio-political domain, Nobel designed a 'unique instrument' (in the form of annual prizes, which later came to be known as Nobel prizes) to recognize merit among those who contributed to social welfare at the global scale. The influence of Nobel's mentors, Nikolai Zinin, Yuli Trapp, Theophile-Jules Pelouze, Ascanio Sobrero, John Ericcson and Immanuel Nobel in igniting Nobel's scientific creativity also deserves recognition. Personal traits that helped Nobel to sharpen his creativity include his business acumen and talent for information access using his multi-lingual skills. © 1999 Harcourt Publishers Ltd

INTRODUCTION

At frequent intervals, medical, chemcial and popular science journals publish commentaries and commemorative notes on the career of Alfred Nobel, the inventor of dynamite and famous benefactor to scientists of the 20th century (1–7). Most of these reports, however, have not delved into the creativity of Nobel, or those who influenced his creativity during his formative years. The present paper is an attempt to fill this gap in Nobel scholarship.

Howard Gardner (8,9) identified five different types of creative activity. These are as follows:

1. solving a well-defined problem by a scientist;
2. putting forth a general conceptual scheme by a scientist;
3. creating a product by an artist that embodies ideas, emotions and concepts;
4. stylized innovation, improvisation and interpretation of an art form by a dance or drama artist;
5. a 'high-stakes' performance by a social or political reformer.

Received 5 September 1997
Accepted 25 August 1998

Correspondence to: Sachi Sri Kantha, 5-16-305 Tsukimicho, Fukuroi City, Shizuoka 437-01, Japan. Phone & Fax: +81 538 49 2274

Among these five types, the scientific domain is represented by the first two types. The third and fourth types are associated with the artistic domain. The fifth type is linked to the socio-political domain. This paper, a continuation of my study of Nobel (10), provides an analysis concluding that Nobel's creative activities belong to the first and fifth types.

MATERIALS

This study draws mainly from information presented in three biographies on Nobel, authored by Evlanoff and Fluor (11), Sohlman (12) and Fant (13).

CREATIVITY OF ALFRED NOBEL

Nobel's creativity can be explored under two mutually exclusive domains. These are:

A. creativity in the scientific domain: contribution to the study of explosives;
B. Creativity in the socio-political domain: designing a 'unique instrument' (in the form of annual prizes, later to be known as Nobel prizes, to recognize merit among those who contributed to social welfare at large).

Table 1 Synopsis of influential events in the formative years of Alfred Nobel

Year	Age (years)	Events
1833	–	Born in Stockholm, Sweden
1842–1849	9–16	Study under private tutors in St Petersburg, Russia
1850–1852	17–19	Study trip to Germany, France, Italy and USA
1853–1856	20–23	Work in St Petersburg, during the Crimean War
1855	22	Receives suggestion from Zinin that he (Nobel) experiment with nitroglycerine as a possible explosive for father Immanuel Nobel's sea mines
1857	24	Bankruptcy of father Immanuel Nobel's business in St Petersburg
1858–1859	25–26	Early patents for gasometer, water meter and improved barometer

(A) Creativity in the scientific domain

Nobel's creativity in the scientific domain is attested to by the 355 patents he received for his inventions (11,14). This aspect of his creativity can be understood by finding answers to questions such as: (1) Who influenced his mind during his formative years? (2) What aspects of his personal traits brought success to his ideas?

INFLUENCE OF MENTORS

A synopsis of influential events in the formative years of Alfred Nobel is shown in Table 1. Due to his ill health and the financial disasters faced by his father, Immanuel Nobel, Alfred Nobel's education consisted of two phases, lasting a total of eleven years:

a. St. Petersburg period, from 1842 to 1849;
b. Foreign travel period, from 1850 to 1852.

Nobel's tutors in St Petersburg were Nikolai Zinin (chemistry), Yuli Trapp (chemistry), Lars Santesson (Swedish language and history) and Ivan Peterov (general studies). When he was between the ages of 9 and 16, Nobel's education followed an unorthodox route in St Petersburg because the then prevailing Russian law forbade non-nationals from receiving a formal education. Subsequently, Nobel came under the influence of Theophile-Jules Pelouze (France) and John Ericcson (USA), when he was sent on an extended study trip to Germany, France, Italy and the USA at the age of 17 by his father.

For an understanding of the devleopment of Nobel's creative talent in the scientific domain, one has to learn about the professional careers of his mentors. In roughly chronological sequence of Nobel's contact with them, brief bio-sketches are presented below of what is known about Nobel's five mentors in science (13,15–19).

Nikolai Zinin (1812–1880)
A leading Russian chemist in his era, Zinin graduated from Kazan University in 1836, and apprenticed under Justus von Liebig at Giessen for about a year in the late 1830s. He then returned as Professor of Technical Chemistry at Kazan University in 1841. In 1848, he received appointment as Professor of Chemistry at St Petersburg Academy of Medicine and Surgery and held this position until his retirement in 1874. In 1842, Zinin described the reduction of nitrobenzene into the aniline and paved the route for the creation of aniline dye industry. He became a tutor to Nobel in the 1840s. During the Crimean War, Zinin also investigated nitroglycerine as an explosive substance.

Yuli Trapp (1808–1882)
Trapp, a Russian chemist, who taught at the Technical Institute in St Petersburg in the 1840s, drew Nobel's attention to nitroglycerine, a heavy yellow oil produced by slowly pouring glycerol into a chilled mixture of nitric and sulfuric acids.

Theophile-Jules Pelouze (1807–1867)
Theophile-Jules Pelouze was a French chemist, who was an apprentice to Joseph-Louis Gay Lussac. By 1830, Pelouze quickly established himself as an outstanding analytical and experimental chemist. In 1838, Pelouze discovered nitrocellulose. He founded the most important private laboratory school of chemistry in Paris, where he trained many students, including Alfred Nobel.

John Ericcson (1803–1889)
Ericcson, a naval engineer and inventor born in Sweden, moved to London in 1826 and lived in England till 1839. Ericcson then left for New York and spent the remaining 50 years in the USA. His claim for fame lies in his design and supervision of the first armored ship, the *Monitor*, during the American Civil War (1861–1865). He offered to construct a vessel for the destruction of the Confederate fleet led by the iron-clad *Merrimac*, for President Lincoln's navy. He completed his job in 100 working days from the date of laying the keel. For his ship, the *Monitor*, Ericcson designed a circular revolving turret, a heavily armored and protected 'gun position'.

Ascanio Sobrero (1812–1888)
Ascanio Sobrero was an Italian chemist, who originally prepared himself to be a medical doctor. When his

doctoral thesis on medicine was rejected, Sobrero switched to studying chemistry in Turin. He then moved to Paris and served as an assistant to Pelouze in Pelouze's private laboratory. Sobrero is credited for the original synthesis of nitroglycerine ('pyroglycerine') in 1847, when he added glycerine to a mixture of nitric and sulfuric acids. Because he suffered serious injury to his face due to the explosion caused during the synthesis of nitroglycerine, Sobrero abandoned this line of work on the belief that such an explosive substance could not be used for industry.

Whether Sobrero can be considered a mentor to Nobel is somewhat questionable. Fant (13) mentions, however, that Nobel shared work space with Sobrero, when both were trainees under Pelouze. So, considering that Sobrero was 21 years older than Nobel, there might have been times that Nobel would have benefited from Sobrero's counsel. Fant also notes that, 'Alfred [Nobel] never entered into public polemics with Sobrero; his contact with him was always deferential. In a letter written from Paris in 1879 to Sobrero, Nobel had observed, 'The whole world owes you a debt of gratitude for your significant invention' (13).

From these bio-sketches of Nobel's mentors in science, one can infer unequivocally that Alfred Nobel's creative stimulus on experimentation with explosives was ignited by the concepts and inventions of his mentors in the field of explosives. Records that reveal to what extent Nobel was influenced by the experimentation of his mentors, however, are rare. Regarding Zinin's tutelage, Evlanoff and Fluor (11) note, 'only the archives of the St Petersburg University could answer the questions of when and how long Nobel worked in Zinin's laboratory'. In a similar vein, Fant (13) has written that, 'precious little is known about Alfred's apprenticeship with Ericcson'.

INfIUENCE OF IMMANUEL NOBEL

Apart from the above-mentioned five mentors in science, the influence of Nobel's father, Immanuel Nobel (1801–1872), on the intellectual development of his son Alfred cannot be overlooked. Immanuel Nobel was an inventor and industrialist, particularly noted for his inventions related to mines and explosives. Having settled in St Petersburg in the 1840s, Immanuel Nobel was considered one of Russia's most competent engineers. He received recognition for his sea mines, employed in the Crimean War (1853–1856) to threaten the English fleet in the Gulf of Finland. Nobel's biographers (11,13) note that the relationship between Immanuel Nobel and his son Alfred turned out to be less than cordial due to differing temperaments and professional competition for recognition. Once the father and son set out to solve the problem of eliminating the instability of nitroglycerine in the early 1860s, they became competitors and as a consequence, their relationship suffered. Caroline Ahlsell Nobel, the mother of Alfred Nobel and wife of Immanuel Nobel, played the role of mediator to bring about a reconciliation. It has been noted that, when the Letterstedt Prize was awarded to both father and son for their work on explosives in 1868, Alfred never forgave his father for retaining the medal without offering it to him.

PERSONAL TRAITS

The influence of his two St Petersburg tutors, Lars Santesson and Ivan Peterov, in moulding the inquisitive, social mind of young Nobel, should not go unrecognized. Fant (13) states that Santesson was a Swede who had a Master's degree in philosophy and who taught language and history to Nobel and his siblings. Peterov taught about the general affairs of the world and instilled in young Nobel's mind the idea of freedom from slavery and Czarist oppression. One personal trait of Nobel that helped him to sharpen his creativity include his talent for information access, via his multi-lingual skills. Despite the lack of formal secondary and tertiary level education, Nobel gained proficiency in six languages, Swedish, French, Russian, English, German and Italian. He also developed the literary skills to write poetry in English. The tutorship of Santesson and Peterov in moulding Nobel's multi-lingual proficiency is worthy of note. It might also be that the bankruptcies that plagued his father strongly influenced Nobel regarding the worth of business success.

RADICAL BREAKTHROUGH AND COMPREHENSIVE WORK

From his studies on the careers of eminent creators, Gardner (9) traced a creativity trend, which he terms the 'ten-year rule', in which 'important events and breakthroughs occurred at approximately ten-year intervals' in the careers of Einstein, Freud, Picasso, Stravinsky, Gandhi and Martha Graham. He has noted that a 'radical breakthrough' occurred after 10 years from the origin of an idea, and 'comprehensive work' followed after 20 years from the conception of the idea. Applying this 'ten-year rule' of Gardner to Nobel's career, reveals a similar trend in his creative pattern, paralleling that of Einstein and Freud (Tables 2 and 3). The 'radical breakthrough' in Nobel's creativity was the invention of dynamite in 1867, which occurred nearly 12 years following his mentor Zinin's suggestion for experimentation with nitroglycerin. The 'comprehensive work' in Nobel's career was the creation of blasting gelatin (gelignite) in 1875, which occurred almost 20 years following Zinin's advice. Nobel further modified his 'comprehensive work' in the subse-

Table 2 Synopsis of Alfred Nobel's creative input to the discipline of explosives chemistry

Year	Inventor	Development
1846	Christian Schonbein	Discovery of gun-cotton (nitrocellulose), by nitrating cotton fiber with a mixture of nitric and sulfuric acids; a more powerful explosive than gun powder.
1847	Ascanio Sobrero	Synthesis of nitroglycerin – by nitration of glycerin; an extremely powerful explosive liquid, but too dangerous to use due to quick ignition when shaken or handled roughly.
1862	Immanuel Nobel	Devising a comparatively simple procedure to manufacture nitroglycerin on a factory scale.
1863	Alfred Nobel	Invention of mercury fulminate detonator for use with nitroglycerin in blasting; his first patent on explosives for a 'method of preparing gun powder for both blasting and shooting.
[1864] – Turning Point in Alfred Nobel's thought process, due to major accident in Nobel factory, killing his younger brother Emil and four co-workers; devises a safer method for handling the sensitive liquid nitroglycerin.		
1867	Alfred Nobel	Patent for dynamite (in Sweden, UK and USA), an easily handled, solid, ductile explosive, consisting of nitroglycerin absorbed by kiesulghur, a porous diatomite mineral, also called guhr dynamite.
1875	Alfred Nobel	Creation of blasting gelatin or gelignite, a colloidal solution of nitrocellulose (gun cotton) in nitroglycerin – an ideal explosive, with power greater than that of pure nitroglycerin, less sensitive to shock and strongly resistant to moisture.
1887	Alfred Nobel	Development of a nearly smokeless blasting powder, called ballistite – a mixture of nitroglycerin and nitrocellulose with camphor and other additives; upon ignition, it burns with almost mathematical precision in concentric layers.

Table 3 Gardner's 'ten-year rule' of creativity leaps for Einstein, Freud and Alfred Nobel

Time frame	Einstein	Freud	Nobel
Origin of idea	Light-beam thought experiment (1896)	Apprenticeship under Charcot (1885–1886)	Zinin's suggestion for experimentation with nitroglycerin (1855)
10 Years (radical breakthrough)	Special theory of relativity (1905)	Interpretation of Dreams (1900)	Dynamite (1867)
20 years (comprehensive work)	General theory of relativity (1915)	Three Contributions to the Theory of Sex (1905)	Blasting gelatin or gelignite (1875)
30 years and beyond	Philosophical works (1925–1945)	Social works (1925–1939)	Smokeless blasting powder or ballistite (1887)

Note: Three columns (time frame, Einstein and Freud) were adapted from Gardner (9) and specific years were added. The column on Nobel was designed by the author.

quent 10 years to develop a nearly smokeless blasting powder (ballistite) in 1887.

Even in the last decade of his life (1887–1896), Nobel continued his research activities. Sohlman (12) listed the various research projects Nobel was handling at the time of his death in San Remo, Italy. These are:

1. the development of artificial rubber, a substitute for natural rubber and for leather based on nitrocellulose and suitable gelatinizing agents;
2. the development of progressive powder, a smokeless gun powder, consisting of layers with differing, and gradually increasing, combustion speeds;
3. the development of ballistite with lower combustion temperatures and reduced corrosion, firing trials with ballistite to determine the pressure generated at varying charge densities;
4. production of nitrocellulose suitable for the preparation of rayon;
5. development of projectile sealing to reduce gun-tube corrosion;
6. development of a rocket camera or photographic telemeter, to achieve photographic mapping of land areas from the sky.

This list reveals the comprehensive nature of Nobel's creativity. A couple of the project goals in this list, such as artificial rubber and aerial photography of land areas, were attained in the 20th century.

(B) Creativity in the socio-political domain

Gardner's fifth type of creativity relates to 'carrying out a series of actions in public in order to bring about some kind of social or political change' (*9*). He described Mahatma Gandhi's protests, fasts and non-violent confrontations (against politicians and bureaucrats who represented the British Empire) to combat racial bias as a typical example of this type of creativity. Nobel's creation of his unique will can be included as another example of this type of creativity. His will can also be equated to a 'unique instrument' designed to bring about some kind of

social or political change in the international arena. Specific stipulations included in the Nobel will (12) demonstrate his magnanimity to fellow humans, his concern for global peace and his wish to eliminate racial bias. These are as follows:

1. 'the capital, invested in safe securities by my executors, shall constitute a fund, the interest on which shall be annually distributed in the form of prizes to those who, during the preceding year, shall have conferred the greatest benefit on mankind'.
2. 'one part to the person who shall have done the most or the best work for fraternity between nations, for the abolition or reduction of standing armies and for the holding and promotion of peace congresses'.
3. 'It is my express wish that in awarding the prizes no consideration whatever shall be given to the nationality of the candidates, but that the most worthy shall receive the prize, whether he be a Scandinavian or not'.

Considering the dominant currents of political and social thought that were prevalent in Europe a century ago (for example, imperialism and belief in racial superiority of Europeans over people of other continents), Nobel's exemplary vision in honoring those who contributed to the 'greatest benefit on mankind' and his desire to elimiante racial bias in the choice of awardees is admirable. Apart from the grieved progeny of Nobel's siblings, quite a number of Swedish elites also expressed their displeasure on Nobel's munificence to society at large (12,13). These included Hjalmar Branting (a journalist cum politician, who was later awarded the 1921 Nobel peace prize), Gosta Mittag Leffler (Nobel's mathematician friend), Professor Knut Ahnlund and even Sweden's King Oscar II. This opposition by Nobel's contemporaries also added luster to the merits of Nobel's unusual creativity, in that he thought and designed 'an instrument' of which even his learned contemporaries did not approve. The press response in Europe to Nobel's 'unique instrument', however, was encouraging (13). These responses include the following:

1. 'This will, whose content without doubt is designed to awaken the attention of the entire civilized world, creates one of the most magnificent dispositions for the good of humanity that any single being has so far been able, and wanted, to make'. (*Nya Dagligt Allehanda*, Sweden)
2. 'The gift is the largest that any single man so far has donated for idealistic purposes . . . In Nobel it (Sweden) has a patron whose nobility surpasses every Croesus, because the benefits of the means he has put into the service of science and humanity are not limited by any national borders'. (*Köln Zeitung*, Germany)
3. 'The will, will remain a monument to philanthropy and thereby save Mr Alfred Nobel's esteemed name from oblivion'. (*Le Figaro*, France)

Crawford (20), in her elegant research on the beginnings of the Nobel Institution, summed the significance of Nobel's will as follows:

> . . . the Nobel prizes had their origin in national prize systems, the French one in particular. Their role as international awards, however, represented a significant break with past practices. Although foreigners were the beneficiaries both of the prizes of the French Academy of Sciences and of the medals of the Royal Society of London, there was no precedent in these or other scientific societies for paying out large sums of money to nationals of other countries. It was also very unusual for such societies to have foreigners participate in the decision making when prizes and medals were awarded. In both respects, the Nobel prizes were to act as precursors and emerge as the first truly international prize in modern times.

Zuckerman (22), identified three areas of recognition acquired by the Nobel prizes with passage of time. These are: (a) serving as a measure of scientific merit or as a gauge of the fruitfulness of new lines of research; (b) serving as a metaphor for supreme achievement; and (c) providing greater visibility and prestige to the recipients. Zuckerman also provided a survey on the recently established prizes which follows the Nobel prize model. She termed these prizes 'Nobel complements and Nobel surrogates' (23). According to her, 'some 3000 prizes in the sciences are available now in North America alone', among which 80% were established within the past 25 years or so. This itself can be considered the best compliment to Nobel's creation.

Nobel's motive for making such a unique will has been postulated. According to Fant (13), Nobel 'was in favor of general prosperity but not of inherited wealth. Large fortunes, he felt, ought to be put back into the public arena . . .'. Biographers have also noted the influence of two of Nobel's peers in the creation of two of the five prizes (literature and peace) stipulated in his will. One was Victor Hugo (1802–1885) who, according to Evlanoff and Flour (11), 'must have indeed helped to plant the seeds of Nobel's plans to use his vast estate for rewards to those human efforts that brought knowledge and help to all mankind'. Bertha von Suttner nee Kinsky (1843–1914) was the other person whose influence is recognizable in the establishment of the peace prize. This Austrian native was 10 years junior to Nobel, when she answered his advertisement for a 'mature lady knowing foreign languages for the performance of the duties of a secretary and housekeeper' in Paris. In his 1892 correspondence to

Table 4 Select list of chemist contemporaries of Alfred Nobel

Name	Lifespan	Country	Achievement leading to fame/ eponymous recognition
Baeyer, Adolf von	1835–1917	Germany	von Baeyer synthesis
Berthelot, Pierre	1827–1907	France	Invented bomb calorimeter
Bunsen, Robert	1811–1899	Germany	Bunsen burner
Cannizzaro, Stanislao	1826–1910	Italy	Cannizzaro reaction
Friedel, Charles	1832–1899	France	Friedel–Crafts reaction
Gibbs, Josiah Willard	1839–1903	USA	Phase rule
Hofmann, August	1818–1892	Germany	Hofmann degradation
Kekule, Friedrich	1829–1896	Germany	Ring formula of benzene
Kolbe, Adolf Wilhelm	1818–1884	Germany	Snythesis of acetic acid
Le Chatelier, Henri	1850–1936	France	Le Chatelier principle
Mendeleyev, Dmitri	1834–1907	Russia	Periodic table
Meyer, Julius Lothar	1830–1895	Germany	Periodic table
Meyer, Viktor	1848–1897	Germany	Vapor density estimation
Newlands, John	1837–1898	UK	Periodicity of elements
Ostwald, Wilhelm	1853–1932	Germany	Ostwald dilution law
Perkin, William Henry	1838–1907	UK	Perkin reaction
Ramsay, William	1852–1919	UK	Discovered rare gases
Solvay, Ernest	1838–1922	UK	Solvay process
Van der Waals, Johannes	1837–1923	Netherlands	Van der Waals' forces
Van't Hoff, Jacobus	1852–1911	Netherlands	Van't Hoff's law
Wurtz, Charles	1817–1884	France	Wurtz–Fittig reaction

von Suttner when the latter organized the Peace Congress in Bern, Nobel wrote with a pithy sense of humor, 'Good intentions alone will not assure peace, nor, one might say, will great banquets and long speeches. You must have an acceptable plan to lay before the governments. To demand disarmament is ridiculous and will gain nothing…' (13). In a subsequent letter to von Suttner, dated 7 January 1893, Nobel had mentioned in what could be labeled as an incomplete, early draft of his will,

> I would like to bequeath part of my fortune for the establishment of peace prizes to be awarded every fifth year (let us say six times, for if at the end of thirty years we have not succeeded in reforming society, we shall inevitably revert to barbarism) to the man or woman who has contributed most effectively to the realization of peace in Europe (13).

Later, Bertha von Suttner herself became the recipient of the 1905 Nobel peace prize.

The significance of Nobel's will (a creation in endowing his business fortune for the benefit of scientists and those who contributed to world peace and the lifting up of the human spirit) can be explained by how Nobel's name is remembered by society now, compared to that of his contemporaries in science. Table 4 shows a select list of Nobel's contemporaries, who established their reputations as distinguished chemists in Europe and the USA. Though their contributions to chemistry were assessed as prominent in the 19th century, with passage of time, their original inventions were modified and even supplanted. Most of them are now remembered only in eponymous laws, rules, reactions, and industrial processes that are largely of historical interest. Furthermore, they remain anonymous among the students of other disciplines or among the public at large. In contrast, Nobel achieved eponymous immortality in the 20th century due to the 'unique instrument' he created in recognizing merit among those who contributed to the social welfare at large.

CONCLUSION

Nobel's creativity can be assigned to two mutually exclusive domains. In the scientific domain, he solved a well-defined problem of his time in the discipline of explosives by taming the volatile nitroglycerin into a useful industrial product. In the socio-political domain, Nobel designed a 'unique instrument', in the form of annual prizes, to recognize merit among those who contributed to social welfare at the global scale. What is unique in Nobel's creativity is that among his scientist contemporaries in the 19th century, only he had the vision to think of such a design and provide the necessary funds and instruction (via his will) for successful implementation.

REFERENCES

1. Jones G. The trial of Alfred Nobel. *New Sci* 1983; Oct. **20**: 189–191.
2. Romm S. Alfred Nobel and his legacy to medicine. *Med Heritage* 1985 **1**(2): 134–136.
3. Synek V. M. Alfred Nobel – the man and the prize. *NZ Med J* 1986; **99**: 589–592.
4. Bendiner E. At Karolinska, research is highly prized. *Hosp Practice* 1987; **22**(10): 187–192.

5. Ljunggren B., Ljunggren M. About the Nobel prize in medicine. *Surg Neurol* 1987; **28**: 331–334.
6. Enever J. Nobel causes. *Chem Brit* 1996; **32**(11): 26–29.
7. Dolan J. E. The richest vagabond. *Chem Ind* 1996; May 6: 348.
8. Gardner H. The creator's patterns. In: Borden M. A., (ed) Dimensions of Creativity Cambridge, MA: MIT Press, 1996: 143–158.
9. Gardner H. Creating Minds. New York: Basic Books, 1993: 359–390.
10. Sri Kantha S. Could nitroglycerine poisoning be the cause of Alfred Nobel's anginal pains and premature death? *Med Hypotheses* 1997; **49**: 303–306.
11. Evlanoff M., Flour M. Alfred Nobel: The Loneliest Millionaire. Los Angeles: Ward Ritchie Press, 1969.
12. Sohlman R. The Legacy of Alfred Nobel; translated by Schubert E, London: The Bodley Head, 1983 (Swedish original, Ett Testamente, published in 1950).
13. Fant K. Alfred Nobel: A Biography; translated by Ruuth M, New York: Arcade Publishing, 1993.
14. Althin T. Alfred Bernhard Nobel. In: Gillispie C. C. (ed) Dictionary of Scientific Biography. New York: Charles Scribner's Sons, 1974: 132–133, vol. 10.
15. Bykov G. V. Nikolay Nikolaevich Zinin. In: Gillispie C. C. (ed) Dictionary of Scientific Biography. New York: Charles Scribner's Sons, 1976: 622, vol. 14.
16. Berman A. Theophile-Jules Pelouze. In: Gillispie C. C. (ed) Dictionary of Scientific Biography. New York: Charles Scribner's Sons, 1974: 499, vol. 10.
17. Messenger C. Ascanio Sobrero. In: Day L., McNeil I. (eds) Biographical Dictionary of the History of Technology. London: Routledge Reference, 1996: 655–656.
18. Johnson A., Malone D. (eds) John Ericsson. In: Dictionary of American Biography, New York: Charles Scribner's Sons, 1931: 171–176, vol. 6.
19. Messenger C. Immanuel Nobel. In: Day L., McNeil I. (eds) Biographical Dictionary of the History of Technology. London: Routledge Reference, 1996: 523–524.
20. Crawford E. The Beginnings of the Nobel Institution: The Science Prizes, 1901–1915. Cambridge: Cambridge University Press, 1987.
21. Nobel Foundation Directory, 1995–1996, Stockholm.
22. Zuckerman H. Scientific Elite: Nobel Laureates in the United States. New York: Free Press, 1977.
23. Zuckerman H. The proliferation of prizes: Nobel complements and Nobel surrogates in the reward system of science. *Theoret Med* 1992; **13**: 217–231.

