Effective Risk Communication in Children’s Environmental Health: Lessons Learned from 9/11

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“... the major public health challenges since 9/11 were not just clinical, epidemiological, technical, issues. The major challenges were communication. In fact, as we move into the 21st century, communication may well become the central science of public health practice.”

Edward Baker, MD, MPH
Assistant US Surgeon General
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The importance of effective risk communication

In situations with real and visible threats to the health of children, such as the World Trade Center disaster on September 11, 2001 (9/11), pediatric health care providers must be prepared to communicate the health risks of environmental exposures in childhood. In most circumstances for the pediatric provider, communication about risk typically is confined to discussions of (1) prognosis of childhood disease or disability and (2) risks and benefits of medical interventions. Discussion of health hazards related to environmental exposure differs in key ways, because the individual providing the information may not be regarded as a reliable source, topics may be unfamiliar to both the physician and the parent or guardian, and there is limited research specifically assessing risks of exposure in childhood [1].

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Parents often turn to the child’s pediatrician with questions about environmental exposures. In a 2002 survey of health care practices affected by 9/11, pediatricians reported that although they responded to numerous questions related to 9/11, they lacked both the training and preparedness to address environmentally related health questions (Y. Yung and D. Laraque, personal communication, 2006). This finding is not surprising, because about one in four medical schools offers no instruction at all in this area, and in the schools that do the mean number of hours of instruction over 4 years of study is less than 10 hours [2]. The inability to convey information about the risk to health arising from exposure to environmental hazards is compounded by the lack of scientific information concerning the more than 80,000 synthetic chemicals produced in the United States since 1950, most of which have not been studied for their developmental toxicity to children [3]. As a consequence, the information parents obtain about environmental exposures is likely to come from sources other than their pediatric provider and may include government agencies, mass media, or websites.

This article describes the theory behind effective communication about risk using illustrative examples from the events that followed the World Trade Center disaster. It discusses in detail the experience of risk communication after 9/11, using outdoor air quality and particulate matter as examples. The authors share key lessons learned and provide a template for communicating risk, which can serve as a guide to developing a public health message for pediatric providers.

Basic principles of risk communication

The practice of risk communication is built on three basic theoretical models: risk perception, trust determination, and cognitive attenuation. These models provide insight into the ways in which an audience forms perceptions about risk, establishes trust, processes information, and ultimately makes decisions about risks. They are evidence based and offer practical tools for health care providers, health educators, and public health officials, all of whom frequently are in the position of communicating information about health risks. Each of the models is discussed in this article [4,5].

Risk perception

A number of factors have been identified that affect how risks are perceived [4,6–8]. Some of the factors influencing the perception of risk are presented in Table 1. As an illustration, consider the parent who is concerned about a child’s ongoing exposure to air pollution from the 9/11 disaster. Simply providing parents with direct actions they can take to control their child’s exposure to airborne pollutants (e.g., cleaning air conditioner filters, damp-mopping hard surfaces, and avoiding exposure to cigarette smoke)
will lower the parents’ perceptions of the risk of the exposure by giving them a sense of control over the situation. The pediatric provider also can reduce the perceived risk of this exposure by making it more familiar and less strange or alien. This is accomplished by substituting common, everyday words for technical terms when discussing a child’s exposure to an airborne pollutant (eg, substituting the words “dust, soot, and smoke” for “particulate matter”). Although effective communication cannot impact all the factors influencing risk perception, an understanding of the qualities that drive the perception of risk provides the communicator with effective tools to determine levels of concern, anxiety, and fear in a given situation. The pediatric provider can use this knowledge to formulate messages that bring the perceived degree of risk closer to reality. In the days and weeks following 9/11, the public was exposed to a variety of pollutants in airborne particulate matter. At the time of the exposure there was much scientific uncertainty and concern about irreversible and dreaded potential health outcomes, such as cancer. These factors, which tend to heighten the public’s perception of risk, were outside the influence of both the general public and the person communicating the risk (often a health care provider or a public health official). As mentioned previously, however, the persons involved in risk communication were in a position to decrease the public’s perception of risk by emphasizing the actions that the public could take to control exposure to the risk (eg, avoiding outdoor activities on days with poor air quality) and using familiar terminology (eg, “soot” instead of “carbon compounds”).

Pediatric providers frequently use comparisons of risk in their discussions with patients and parents. Understanding the factors that influence the perception of risk can help the risk communicator avoid a common error in risk comparisons. Attempts to compare two risks with different risk perception profiles in an effort to make the risk more familiar frequently result in

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<th>Table 1</th>
<th>Factors affecting the perception of risk</th>
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<tr>
<td><strong>Factor</strong></td>
<td><strong>Risks perceived to be under an individual’s control</strong></td>
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<tr>
<td>Control</td>
<td>under control</td>
</tr>
<tr>
<td>Familiarity</td>
<td>familiar</td>
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<tr>
<td>Trust</td>
<td>associated with a trusted source</td>
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<tr>
<td>Certainty</td>
<td>known to science</td>
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<td>Reversibility</td>
<td>reversible</td>
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<td>Voluntariness</td>
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<td>Origin</td>
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<td>Fairness</td>
<td>distributed equally</td>
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<td>Victim’s age</td>
<td>affecting adults</td>
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<tr>
<td>Dread</td>
<td>associated with less dreaded outcomes</td>
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audience rejection of the comparison, hostility toward the communicator, and a breakdown in communication. An example of this situation is comparing the risk of dying in an earthquake in California with that of dying in another terrorist attack like 9/11, a comparison of a familiar, natural, evenly distributed risk affecting all members of the population equally with a risk that is strange, generated by humans, and unevenly distributed among a small portion of the population.

In the aftermath of 9/11, successful comparisons of air quality were made to historical background levels. Other generally accepted comparisons can be made to state and federal health-based standards, or, in their absence, to historical background levels. Although the latter address the risk indirectly, they provide a valuable frame of reference for the public.

**Trust determination**

A consistent theme in the literature concerning risk communication is the need to build trust [9–12]. When trust is present, perceptions of risk are lowered; when trust is absent, perceptions of risk are heightened. Building trust is integral to communicating risk effectively [4].

Four factors have been identified as key determinants of trust: the perception of (1) care and empathy; (2) honesty and openness; (3) dedication and commitment; and (4) competence and expertise [10]. Empathy is a particularly important part of communications regarding health risks [13]. As Will Rogers pointed out, “When people are upset, they want to know that you care...before they care what you know.” Moreover, it has been shown that perceptions of care and empathy are the strongest factors for creating trust when people are highly concerned, anxious, or fearful [14,15].

Pediatric providers can enhance patients’ perceptions of care and empathy in several ways, including active listening (eg, providing feedback and paraphrasing), mirroring (eg, identifying underlying similarities between the pediatric provider and the audience such as marital status; children, if any; and similar personal details), and removing physical barriers (eg, crossed arms, desks, podiums). The last is of particular importance because nonverbal communications often convey more than do spoken words.

When possible, it is best to choose a communicator who resides in the community. Even so, there frequently are differences in race, culture, education, and economic status. A communicator, regardless of his or her background, may highlight other points of commonality, such as parenthood, thus bridging the gaps between the communicator and the audience.

Health care providers generally are perceived as caring, honest, dedicated experts, and they have emerged as one of the most trusted and credible sources of information about environmental health risks [15]. Yet, when perceptions of risk are elevated and people are highly concerned, anxious, or fearful, the need to build trust may still exist, and simple displays of care and empathy can facilitate effective communication.
Cognitive attenuation

Research has shown that individuals experiencing high levels of concern, anxiety, or fear, whether caused by real or perceived threats, demonstrate diminished ability to process information [5]. Cognitive attenuation, also known as mental noise, can restrict communication severely. Pediatric providers may experience this situation when presenting bad news to patients or their parents. Bad news elevates concern, anxiety, and fear, resulting in limited ability to process or retain information. When mental noise is present, a narrow window exists for communicating information to individuals who are highly concerned, anxious, or fearful [16]. Measures to overcome mental noise in situations of high concern are discussed in the next section on developing a message for communicating risk.

Developing a message for communicating risk

Several rules have been developed to facilitate more effective discussions communicating risk. The first is the rule of three, based on research in cognitive load theory, which finds that people can process only two or three items of information at a time [17]. In practical terms, people have a strong ability to recall triplets. This pattern is displayed in many areas, including sporting events (“three strikes and you’re out”), nursery rhymes (“three blind mice”), memorable phrases (“life, liberty, and the pursuit of happiness”) and even medical symptoms, which are often grouped in three’s (e.g., Cushing’s triad and Virchow’s triad). Applying this rule dictates that communications be limited to three key messages. Further, each key message should be supported by only three facts, each supported by a further three facts. In this way, an information pyramid can be built that will enable a pediatric provider to present information that is accessible to the audience.

The second is the rule of negative amplification. This rule is based on the research finding that people accept risks associated with gain and avoid those associated with loss [18]. In addition, when facing a loss, persons give greater weight to negative information. For example, most patients would be more likely to choose a surgical procedure with a 95% success rate than one with a 5% failure rate. This finding has several implications. One is that negative information should be balanced by a larger amount of positive information. Another is that statements containing negatives (no, not, never, nothing, none) receive greater listener attention and should be avoided. Lastly, the framing of risk information can influence the acceptability of risk and ultimately the decisions a family makes regarding risk.

The third rule is to keep the message short and simple. Responses to questions are best kept to 2 minutes or less. This technique has several advantages. It helps avoid complex, possibly confusing responses; it offers increased opportunities to determine audience understanding; and it allows the time needed for listening. Clear, simple, straightforward language should
be used when addressing highly concerned, anxious, or fearful adults. Language three grade levels below that attained by the adult, determined by vocabulary, sentence length, and construction, often is most successful. Because most adults have, at the minimum, a high school education, language at the ninth grade level often is suitable. When addressing audiences with less education, a lower grade level would be appropriate. To improve clarity, it is necessary to define terms plainly and to avoid acronyms (such as “CBC” for “complete blood count”) and jargon (such as the use of the term “acute asthma exacerbation” instead of “asthma attack”). Although these restrictions may be lifted when speaking with medical or other professionals, retention often is enhanced when these rules are followed. For all audiences, the use of visual materials (including pictures, drawings, and graphs) greatly increases comprehension and understanding.

This section has discussed broadly the theoretical foundations of risk communications about risk and has provided some simple guidelines for their application (Fig. 1). In advance of an actual event, such as a terrorist attack, hurricane, or flood, professionals and public health officials often need to (1) identify potential issues; (2) prepare messages; and (3) identify spokespersons and credible subject matter experts in relevant fields (eg,
risk communication, pediatrics, toxicology, epidemiology, and public health) and train them in applying the tools and techniques of communicating about risk, a few of which have been presented here. There also is a need to select the best means for conveying information, recognizing that face-to-face dialogue is optimal when communicating risk. For further information on principles for communicating about risk and practice, please refer to Box 1.

Case study on risk communication in the aftermath of the World Trade Center disaster

In the aftermath of 9/11, environmental pollutants were evident at businesses, schools, homes, places of worship, public areas, parks, and playgrounds located in the lower Manhattan area. The population was in a state of shock and fear, which presented a significant challenge to communication

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| Agency for Toxic Substances Disease Registry: A Primer on Health Risk Communication Principles and Practices  
www.atsdr.cdc.gov/HEC/primer.html |
| Agency for Toxic Substances Disease Registry: ToxFAQs  
http://www.atsdr.cdc.gov/toxfaq.html |
| Association of Occupational and Environmental Clinics- Pediatric Environmental Health Specialty Units (PEHSU)  
http://www.aoec.org/PEHSU.htm |
| Centers for Disease Control: Emergency Risk Information  
www.cdc.gov/communication/emergency/features/f001.htm |
| Center for Risk Communication  
http://www.centerforriskcommunication.com/home.htm |
| Environmental Protection Agency: Considerations in Risk Communication: A Digest of Risk Communication as a Risk Management Tool (Revised)  
http://www.epa.gov/ORD/NRMRL/pubs/625r02004/625r02004.pdf |
about risk. Public officials and individual physicians were faced with urgent inquiries about the health risks of the environmental exposures in lower Manhattan. Assistance was sought from many directions including the Pediatric Environmental Health Specialty Unit (PEHSU) in New York City, a resource that provides consultations for children who have toxic environmental exposures and diseases of suspected environmental origin. Parents calling the PEHSU asked whether it was safe to return home, what cleanup was recommended, and whether these exposures caused a child’s asthma. Expectant mothers asked about the health of their unborn babies. Pediatricians called asking whether to expect long-term health effects related to these exposures. Schools asked when it was safe for students to return.

The situation after 9/11 presented a number of challenges to communication about risk. Many factors increased the public’s perception of risk: the situation was beyond the individual’s control, was unfamiliar to Americans, was imposed maliciously on the city by humans, and involved potential serious health effects resulting from environmental exposures about which the science was uncertain at best. The first communicators of information and risk were government officials who were not always physicians. Because government officials usually do not carry a high level of trust, their prominent position as communicators about risk often increased the public’s perception of risk. Further, the public was faced with a barrage of often conflicting, technical, and complicated information that, given the extraordinarily high level of concern present after 9/11, was beyond its ability to process, assimilate, and retain.

To deal with these challenges, risk communicators used a number of strategies with varying degrees of effectiveness. One of the most important approaches was to present specific steps that members of the public could take to assert some level of control in their lives and reduce their exposure to potential environmental hazards, particularly dust, soot, and smoke in the air. The New York City Department of Health, the PEHSU, and the Environmental Protection Agency (EPA), among others, rapidly produced and distributed specific guidance using lay terminology. They provided advice on reducing exposures when airborne particulate matter levels were high (eg, avoiding vigorous outdoor exercise, keeping windows closed, and replacing filters on air conditioners), thus giving the public a level of personal control and reducing both anxiety and the perception of risk. This information was distributed through the media, in print, and on the Internet.

A major difficulty in assessing environmental risks to children is the large gap in knowledge regarding exposure limits for children ages 0 to 18 years and in utero. Current acceptable threshold levels for many environmental exposures are based on healthy adults in the workplace setting and do not take into account vulnerable populations with unique susceptibilities to environmental exposures, including children, the elderly, and those who have chronic health conditions (eg, heart disease and asthma).
In the aftermath of 9/11, successful comparisons of air quality were made to historical background levels. Other generally accepted comparisons were made to state and federal standards or, in the absence of such standards, to concurrent background levels. This method proved useful for comparison of both dose and duration of exposure. Although this information provided limited information on the potential for long-term health consequences of exposure, it did establish an effective and adequate frame of reference. When the magnitude of the exposure is in concordance with either current or historical background levels and is of brief duration, this sort of comparison can provide reassurance to families in the absence of evidence-based reference values or health-based exposure standards.

This general approach was employed successfully for 9/11-related exposures such as volatile organic compounds (commonly referred to as solvents), dioxins (byproducts of combustion), polychlorinated biphenyls (chlorinated hydrocarbon compounds used as coolants and lubricants), and even for toxins with existing reference ranges for sensitive populations, such as lead. For example, both the collapse of the World Trade Center and the continued fires at the site led to the release of particulate matter, microscopic particles referred to as “PM2.5” and “PM10” based on the size of the particles. Particulate matter is a major indicator of outdoor air quality, and several regulatory agencies, including the EPA, monitor levels in the air on a continuous basis in urban, suburban, and rural areas. EPA data indicate that in the immediate aftermath of 9/11 there were large increases in short-term levels of PM2.5 at and above the Air Quality Index level of 40 µg/m³. In general, these elevations of particulate matter levels followed the path of the smoke plumes, depending on wind direction. Levels of particulate matter were higher at night, in part because of changes in temperature and air movement, and were lower on rainy days because the rain washed some of the particulate matter from the air. Although some hourly levels as high as 200 µg/m³ were reported, 24-hour averages for these same areas were significantly lower, at 40 to 90 µg/m³.

In the days following 9/11, various messages released by government officials, health care professionals, scientists, and the media ran the gamut from reports of extremely unsafe levels of outdoor air pollutants to the EPA’s statement on September 18, 2001, that “the air was safe to breathe.” Public concerns remained, however, because families and workers in the World Trade Center area could see and smell fumes from ongoing fires. At a time when there was immense fear and sorrow, because the disaster was of unprecedented scale for New York City, the disparity between what residents and workers were seeing downtown and what they were hearing on the news led to a great deal of confusion.

In the immediate aftermath of 9/11 families were faced with major decisions regarding return to work and to their homes and their children’s return to school. Messages that simply conveyed the facts and were laced with technical jargon without providing context often were alarming to the public.
Consider the following statement: “EPA data indicate there were large increases in hourly levels of PM2.5 at and above the Air Quality Index level of 40 \( \mu g/m^3 \). Some hourly levels were reported as high as 200 \( \mu g/m^3 \).” This statement uses technical terms such as “PM2.5” and “Air Quality Index” that are unfamiliar to the public. No interpretation is offered as to the potential health effects of exposure to this level of air pollution, and no historical comparison is cited. It should not be surprising that a fearful audience might conclude that the state of the air quality in and around the World Trade Center site was unsafe.

A message explaining the current levels of exposure in comparison with other urban areas or using New York City’s own historical levels provided the public with more relevant, accessible, and understandable information needed for decision making. For example, one could amend the message by stating, “Although these 24-hour levels are higher than desirable, they are similar to background levels of air pollution seen previously in New York City.” Placing the information in context creates a message that the audience can comprehend more readily.

PEHSU staff participated in numerous community forums in which potential health risks were discussed and recommendations were offered. These forums provided opportunities for the public to express its concerns and for risk communicators to listen and express empathy. Also, the PEHSU staff at the forums included pediatricians with expertise in environmental threats to children’s health. These factors enhanced the public’s level of trust and confidence in the information presented. At the forums, PEHSU staff shared its review of environmental testing results from both governmental agencies and private firms and then looked to historical environmental testing results for the same areas. Data before 9/11 revealed historical outdoor levels of 18.4 \( \mu g/m^3 \) for PM2.5 (year 2000 average) and levels of 25 \( \mu g/m^3 \) for PM10 (1998 average). Twenty-four–hour levels for New York City have been reported as high as 89 \( \mu g/m^3 \) for PM2.5 and 121 \( \mu g/m^3 \) for PM10 (1996–2001, pre-9/11). This information indicated that even pre-9/11 levels of particulate matter exceeded the National Ambient Air Quality Standards, most likely reflecting background levels of air pollution in urban areas. Although this information stresses that much work is yet to be done to improve the overall quality of outdoor air, it helped place the World Trade Center exposures in context.

Guidance provided to families explained that long-term health effects were unlikely to result from short-term exposures to particulate matter and noted that acute reversible health effects including asthma exacerbations and eye, ear, nose, and throat irritation were possible. Fact sheets were created specifically outlining World Trade Center–related exposures and potential health risks to children including particulate matter (Box 2), lead, asbestos, polychlorinated biphenyls, volatile organic compounds, and dioxins. These fact sheets were distributed at community forums and through community-based organizations and are also accessible online.
Box 2. Particulate matter fact sheet

What is particulate matter?
Particulate matter is the name or term used to describe a variety of small, microscopic particles in the air. The particles include dust, soot, smoke, and cigarette fumes. Also, byproducts of combustion, or burning, such as sulfur dioxide and nitrogen dioxide, are components of particulate matter. Together, these are often called “outdoor air pollutants” and are a major indicator of overall air quality.

What are the sources of particulate matter?
The major sources of particulate matter include the tailpipes of motor vehicles and the smokestacks of factories; mining, construction and demolition; and fires and natural soil erosion.

What determines a child’s level of exposure to particulate matter?
A child’s level of exposure to particulate matter depends on the distance of the child’s home and school from sources of particulate matter, including major roads, bus stations, and construction sites. In general, cities have higher levels of particulate matter than suburban areas.

What else can affect levels of particulate matter in the air?
Levels of particulate matter are affected by the weather, and levels can change depending on the time of day. High winds help spread particulate matter and can decrease levels of particulate matter in the air. Rain washes particulate matter from the air, lowering air-borne levels of particulate matter. During rush hour, heavy traffic and road congestion result in increased vehicle emissions and higher levels of particulate matter.

How does particulate matter affect the health of children?
Short-term exposure to particulate matter may irritate the eyes, ears, nose, throat, and lungs. Symptoms may include coughing, wheezing, and shortness of breath. These symptoms usually stop when the exposure is removed. Children who have asthma may experience an acute asthma attack or worsening symptoms when exposed to high levels.

Is my child at risk of health effects from exposure to particulate matter after the collapse of the World Trade Center?
Although high levels of particulate matter were present immediately after 9/11, levels steadily decreased and by
mid-October were consistent with normal background levels for New York City. Reversible, short-term eye, ear, nose, and throat irritation and asthma were likely during the initial period following the collapse. Long-term health effects are unlikely to result from short-term exposure to particulate matter.

How do we prevent further exposure?

Take steps to minimize exposure to particulate matter:
1. Check outdoor air quality alerts. If outdoor levels are high, keep windows and doors closed to keep out the particles and limit the amount of time children play outdoors.
2. Have the filters in your air conditioning and ventilation systems inspected and changed regularly.
3. Prevent particles from spreading in the air by using a High Efficiency Particulate Air (HEPA) vacuum and damp mops or damp cloths to clean inside your home.

A sample message communicating information about risk incorporating the principles discussed in this article and the risk-communication template is included in Fig. 2. Given what was learned from providing health messages to families in the aftermath of 9/11, the template for communications about risk is a clear and concise way to get a message out to the public. Consultation between medical professionals and experts in a variety of fields including risk communication, environmental health, industrial hygiene, and public health is sometimes necessary in developing these types of messages, particularly in complex situations such as after 9/11.

Discussion: putting principles into practice

Addressing parent and guardian concerns about environmental hazards can pose a challenge to pediatric health care providers. Although they may not view themselves as experts in the field of environmental risk assessment and communication, pediatric providers do have certain inherent qualities that make them ideal for communicating information regarding potential environmental health hazards to families and to the community at large. Pediatric providers are credible sources of information, they are trusted by the families of the children they care for, and they are skilled at discussing delicate information.

Miller and Solomon [1], in an adaptation of the “Seven Cardinal Rules of Risk Communication,” describe guidelines for clinicians to consider in their practice when communicating risk. The rules are (1) accept and involve the patient as a legitimate partner; (2) plan carefully and evaluate your efforts; (3) listen to the patient’s specific concerns; (4) be honest, frank, and open;
(5) coordinate and collaborate with other credible sources; (6) meet the needs of the media; and (7) speak clearly and with compassion [19,20].

Pediatric providers can best advocate for the health of children in the face of environmental disasters, both man-made and natural, by speaking from

**Box 3. Key lessons learned**

1. Focus on factors that can reduce perception of risk, such as providing concrete practical advice that can give the public some level of individual control.
2. In the absence of health-based exposure thresholds, background levels (both present-day and historical) are useful for providing a contextual framework.
3. Use the word “safe” cautiously. Provide specific details: safe for whom, from what, at what time periods, and for how long.
4. Choose risk communicators who carry a high level of public trust such as physicians. Information from independent, academic sources often is viewed as unbiased and reliable.
5. In a time of high concern it is important to craft clear and concise messages, using lay terminology.
their strength as trusted experts on children’s health, obtaining the necessary information from experts in allied fields, and developing a clear message that keeps in mind the basic principles of risk communication (Box 3).

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References