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Toward improved education of the public about methicillin-resistant *Staphylococcus aureus*: A Mental Models Approach

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Abstract

Methicillin-resistant *Staphylococcus aureus* (MRSA) is ever more becoming a public health problem, due to its prevalence among cattle, raw meat, and otherwise healthy people. Therefore, it is essential that risk communication promotes awareness and recognition of MRSA among the general public, so they can adopt preventive health and infection control measures. In order to do so, a public website for the Dutch general public was developed. Because effective risk communication should be tailored to the public's relevant beliefs and knowledge ("mental models"), we identified the mental models of the Dutch general public concerning MRSA by means of 17 interviews followed by a confirmatory questionnaire (n=239). Although the majority of the public (62%) heard of MRSA and its well-known risk factors and consequences before via the media, the public was only slightly aware of its threat to society. Misconceptions existed regarding origin and spread (e.g., that MRSA is caused by overburdened muscles). Besides, knowledge gaps were detected concerning prevention, reservoir, and origin (importance of hygiene measures, presence on the skin, MRSA among cattle). These misconceptions and knowledge gaps were corrected in the content of the public website next to basic scientific information about MRSA, which was evaluated by means of a usability test (n=18). Overall, our findings highlight the need for the systematic analysis of the public's mental models prior to designing risk communication.

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Introduction and background

Carried by healthy people, methicillin-resistant *Staphylococcus aureus (*MRSA) is usually harmless. However, a newer form of MRSA known as Community Acquired (CA-)MRSA, has appeared with increasing frequency and is now epidemic within certain community populations among persons without any established risk factors. Given that in the Netherlands MRSA also appears to be ever more prevailing among cattle and in raw meat since 2005 and 2007 respectively, MRSA is becoming a major public health issue, affecting thousands of healthy people.[1,2]

Next to an increased mortality and morbidity rate, infections caused by (CA-)MRSA lead to extreme costs due to increased staffing needs, prolonged hospital stays, antibiotic treatments et cetera.[3] Also, depressive and anxious symptoms ubiquitously prevail among MRSA-infected people.[4] For these reasons, the problem of MRSA has to be structurally addressed. An effective strategy to prevent and control MRSA includes effective surveillance, early detection, adequate treatment, but also better risk communication about MRSA to the general public.[5]

Risk communication is communication intended to supply laypeople with the information they need to make informed, independent judgments about risks to health, safety, and the environment.[6] Risk communication about MRSA should promote awareness and recognition of MRSA among the general public, so they can adopt preventive health and infection control measures.[7] For instance, this implies that the public must learn to avoid contact with other people's wounds or bandages, avoid sharing personal items such as towels or razors, and practice good personal hygiene.[8] We intended to develop risk communication about MRSA that included such information.

Risk communication can be disseminated by a broad range of media. We chose to provide the public with MRSA-related risk communication via a website, since widespread Internet use has revolutionized health information and education. In the Netherlands, the percentage of persons with access to the Internet increased to 91% in 2008,[9] and 60% of the Internet users search for health information for themselves.[10] Furthermore, although Dutch educational websites about MRSA are available for health care professionals, none appeared yet to exist for the general public.

The design of most risk communications relies primarily on intuition and conventional wisdom among experts, rather than on evaluation by its intended users. Under such conditions, it is not surprising that audiences often miss the point and become confused, annoyed or disinterested. To overcome this problems, it is essential that risk communications fit in with the public's mental model of the risky process, allowing people to know which facts are relevant and how they fit together. We therefore systematically analyzed the Dutch general public's mental models concerning MRSA prior to the design of the website, by employing the Mental Models Approach.[7] The Mental Models Approach is a public-centered method to developing risk messages and offers a way to ensure that laypeople can understand how the risks they face are created and controlled. The approach attempts to be faithful simultaneously to scientific and individual realities, both of which are essential for effective communication. This paper describes the steps that were followed in order to design and evaluate risk communication about MRSA that dovetails with the general public's mental models.

Methods

The approach comprises five steps. Following these steps guarantees that relevant scientific information fits in with the public relevant beliefs and knowledge, so chances for effective risk communication increase.[7]

Step 1: Creation of an expert model

Current scientific knowledge was reviewed about the processes that determine the nature and magnitude of the risk related to MRSA. It was summarized from the perspective what can be done about the risk. This so-called expert model was reviewed by a medical microbiologist in order to ensure correctness. Concepts of the expert model include prevention, spread, reservoir, origin, risk factors, contamination, treatment, and consequences.

Step 2: Open-ended interviews

Based upon the content of the expert model, we set up an interview protocol which was deliberately designed to be open-ended, so as to elicit each subject's complete knowledge of MRSA without asking leading questions. It allowed the expression of both correct and incorrect beliefs. Responses were analyzed in terms of how well these mental models correspond to the expert model.

We conducted street interviews with 9 male and 8 female participants. Their mean age was 47.7 years (SD: 20.4, range 20-81 years), and education level varied from elementary school to university. The interview time depended on the subject's knowledge about MRSA and varied from 5 to 20 minutes.

Step 3: Confirmatory questionnaires

The interviews revealed a mixture of (in)correct beliefs, which we used to construct a structured 83-item self-administered questionnaire that we conducted among a larger sample to estimate the prevalence of these beliefs among the general public. Items were all answered on a 5-point scale comprised of "true", "probably true", "don't know", "probably false", and "false". Furthermore, the questionnaire included items measuring several demographics. Respondents were recruited on board of the Dutch train in order to obtain a diverse sample. While travelling all over the Netherlands on board of an intercity train during four days, we expected to encounter people who span a range of socioeconomic and educational backgrounds. The sample size had to be comprised of 100-300 people. This number is sufficient, since the principal objective was to get a reliable notion of the rough prevalence of key beliefs in the target audience and we were not trying to test specific hypotheses with an accuracy of a few percentage points.[7]

Questionnaires were administered by a single investigator. All travelers in one train compartment were approached and asked if they had time to fill in a questionnaire. Those who agreed, simultaneously filled in the self-administered questionnaire and as soon as everyone was finished, the investigator collected the questionnaires and headed to the next compartment. The majority of people agreed to participate. The exact number of non-response was not recorded since the management of disseminating and collecting the questionnaire required all of the investigator's time and effort. After completing the questionnaire, participants received a brochure with information about MRSA, to eliminate unnecessary fear that the questionnaire had possibly evoked.

In total, 239 people answered the questionnaire completely. 54% were female, 96% Dutch, mean age was 30.7 years (SD: 16.0, range 13-82 years), and education level varied from low (41%), medium (21%), to high (38%). Eleven percent had been hospitalized during the past year, and 3% had had something to do with MRSA. All data were processed and analyzed using SPSS 14.0.

Step 4: Draft risk communication

We used the results from the interviews and questionnaires to determine which incorrect beliefs needed correcting and which knowledge gaps had to be addressed on our website, next to the scientific information from the expert model (see Figure 1). The website was subjected to expert review by a medical microbiologist to ensure its accuracy.

Step 5: Evaluate risk communication

Draft communications always need testing with people drawn from the target audience, as it is often very difficult for communicators to understand intuitively what a first-time user of their communication means experiences.[7,11] Therefore, we conducted a usability test (n=18) in order to evaluate the draft version of the website. Respondents were recruited by means of snowball sampling: the first set of respondents were personal contacts of the principal investigator. Those respondents recruited other respondents from among their acquaintances. Seven respondents were male, eleven were female. Mean age was 36.6 years (SD: 12.5, range 17-57 years), and education level varied from low (11%), to medium (33%), and high (56%).

Respondents were asked to solve MRSA-related tasks using the website. The tasks covered all concepts of the expert model. For instance: *"Look up on the website which measures you should take in order to prevent an MRSA-infection."* In order to detect problems, respondents were asked to think aloud. The usability problems that arose during the tests were fixed before the website was officially implemented.

Results

Step 1: Creation of an expert model

Figure 1 depicts the expert model. During website design, we continuously kept in mind this expert model in order to ensure each concept was represented in the website's content.

Step 2: Open-ended interviews

The interviews demonstrated that several misconceptions about MRSA existed among the general public. These misconceptions, separated by the concepts from the expert model (see Figure 1), are shown in Table I. Some respondents thought MRSA to be a muscular disease, or an immunity disorder. Remarkably, some others perceived MRSA as similar to Repetitive Strain Injury:

"MRSA, ehm, doesn't that mean that you're having a mouse wrist or anything like that?"

Table I further shows that misconceptions mainly concerned prevention, risk factors, and contamination. For example:

[When asked about prevention]: "So we can get rid of MRSA that way… By injecting people. *Inject? With a vaccine or something?* Yes, a vaccine."

[When asked about risk factors to acquire MRSA]: *"I live healthy, here, look, I have a banana and a bottle of water with me […] MRSA is caused by an unhealthy lifestyle, but I am a very healthy man."*

It appeared that the participants' correct knowledge was concentrated around the constructs risk factors and spread, although here also some misconceptions appeared to exist:

[When asked how MRSA spreads:] *"Maybe in the swamps, that you get a bite from an eeh… insect that transmits it to.. I believe it gets into our country like that."*

Step 3: Confirmatory questionnaires

Although the majority of the sample (62%) had heard of MRSA before via the media, the questionnaire confirmed the existence of important misconceptions and knowledge gaps (see Table I).

The participants held correct beliefs concerning risk factors of MRSA: The majority knew that a weakened immune system (75%), poor hygiene (64%), cuts or abrasions (56%), and hospital admission abroad (54%) are risk factors for acquiring MRSA. This might be due to the fact that the risk factors and transmission routes for MRSA also hold for general health threats. Specific MRSA risk factors were less well-known, such as crowded living conditions (32%) and skin problems like eczema (14%). Furthermore, respondents seemed to be aware of the major consequences of MRSA, such as that MRSA may cause infections (73%), and that a patient with MRSA might have a longer hospital stay than usual (68%).

Regarding misconceptions, it appeared that the idea of MRSA being a muscular disease was shared by 26% of respondents (answering "true" or "probably true"), even as the incorrect belief that MRSA is a contagious virus (36%). Also, respondents held inadequate beliefs with regard to prevention, reservoir, spread, and consequences of MRSA. Despite hygiene measures being the most important way of MRSA prevention, only 34% of respondents seemed to be aware of that. 16% incorrectly assumed vaccination would prevent MRSA-colonization, and 6% thought that being in the open air also impedes MRSA-colonization. The results further suggest that the respondents were not sure where to find MRSA on the body: while 39% thought MRSA can be found in the blood, only 16% assumed MRSA lives on the skin. 7% supposed MRSA is transmitted by insects. Only 21% knew MRSA can be possibly transmitted from animals to humans. 51% incorrectly thought that colonized patients are not allowed to leave the hospital as long as they have MRSA and 45% thought that patients with MRSA cannot undergo surgery.

Table I: Present beliefs among the Dutch general public about methicillin-resistant Staphylococcus aureus, based on interview (n=17) and questionnaire results (n =239)

Concepts from the expert model	Incorrect beliefs*	%	Correct beliefs	%
What is MRSA?	**MRSA is an illness.**	**51**		
	MRSA is a contagious virus.	**36**		
	MRSA is a muscular disease.	**26**		
	MRSA is an immunity disorder.	**24**		
	MRSA is another word for mouse wrist.	9		
	MRSA is a classical tropical disease.	5		
Prevention	**MRSA cannot be prevented by good hygiene.**	**32**	Patients with MRSA have to be treated in isolation in the hospital	59
	Injection with a vaccine can prevent from MRSA.	16	Disinfection measures are a way of preventing MRSA.	54
	People that are a lot outside cannot acquire MRSA.	6	**Recent hospitalization abroad is a reason for being nursed in isolation.**	**29**
Spread	MRSA is usually spread by insect bites.	7	MRSA spreads through the environment.	48
			MRSA spreads through skin-to-skin contact.	41
			MRSA is possibly spread by animals.	**21**
			MRSA is brought to the Netherlands by travellers to countries far away.	**28**
			MRSA is brought to the Netherlands by immigrants to countries far away.	**20**
Reservoir			MRSA can be found in the blood.	39
			MRSA can be found in the mucous membranes, like the nose and throat.	**29**
			MRSA can be found on the skin.	**16**
			MRSA can be found in the hair.	**6**
Origin	**At some hospitals MRSA just returns, like it has never been gone.**	**44**	MRSA can be found in hospitals.	84
	MRSA can only be found in hospitals, e.g., in operation theatres.	23	MRSA can be found among the general population.	62
	MRSA is a hospital bacterium and therefore of no danger to society.	10	MRSA can be found in nursing homes.	51
			MRSA can be found among cattle (e.g., pigs and cows).	**22**

Concepts from the expert model	Incorrect beliefs*	%	Correct beliefs	%
Risk factors	MRSA is caused by overburdening the muscles.	20	One can be more susceptible for acquiring MRSA than another.	67
	One who never visits the hospital will not acquire MRSA.	18	Poor hygiene increases one's risk of acquiring MRSA.	64
	MRSA is caused by an unhealthy lifestyle.	16	Cuts or abrasions increase one's risk of acquiring MRSA.	56
	MRSA is caused by alcohol and/ or drug abuse.	5	Recent hospitalization abroad increases one's risk of acquiring MRSA.	50
			Crowded living conditions increase one's risk of acquiring MRSA.	32
			Skin-to-skin contact increases the risk of MRSA.	**29**
			Skin problems, like eczema, increase the risk of MRSA.	**14**
Contamination	**MRSA starts with high fever like influenza.**	**30**	One can carry MRSA without becoming ill.	49
	MRSA can be mostly found among elderly,	**29**		
	One can be immune to MRSA.	18		
Treatment			Early treatment of MRSA decreases the mortality rate.	53
			MRSA can only be controlled with specific antibiotics.	48
			Most antibiotics are not effective to treat MRSA.	37
Consequences	**Patients with MRSA are not allowed to leave the hospital as long as they have MRSA,**	**51**	MRSA may cause an infection.	73
	Patients with MRSA cannot undergo surgery.	**45**	A patient with MRSA might have a longer hospital stay than usual.	68

* Beliefs elicited during street interviews (n=17). The third and fifth column display the population prevalence of the beliefs, as resulted from the confirmatory questionnaires (n=239). Each belief was measured as a separate item. Top ten incorrect beliefs and bottom ten correct beliefs are in bold.

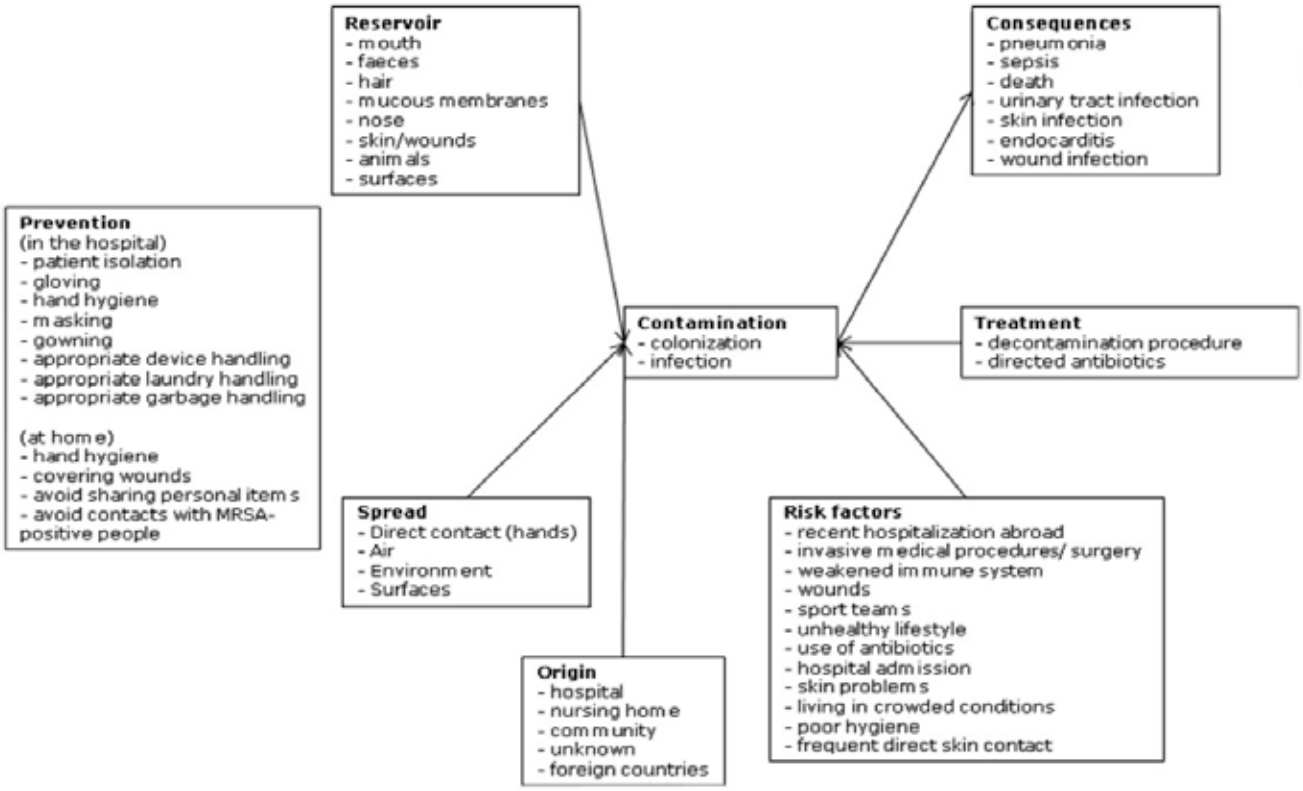

Figure 1. Expert model regarding prevention, reservoir, spread, contamination, origin, risk factors, consequences, and treatment of methicillin-resistant *Staphylococcus aureus*.

Table II: Example of question and answer from the public website about methicillin-resistant Staphylococcus aureus, correcting the misconception "MRSA is an illness"

Question	**Is MRSA an illness?**
Short answer	No. MRSA is not an illness, but a bacterium. Healthy people won't even notice that they carry MRSA. However, at patients with open wounds, invasive devices, and weakened immune systems, MRSA can cause infection, with serious consequences such as pneumonia and sepsis (blood poisoning). In this case, the illness or disease is caused by the infection, but not by MRSA itself.
Comments	Carried by healthy people, MRSA is usually harmless. The bacterium will disappear quickly without any consequences.

Note. 1= Search engine; 2= Categories; 3=Frequently Asked Questions; 4= Breadcrumb trail; 5=Answer title; 6= Short answer; 7= Video.

Figure 2. Screen capture of the public website about methicillin-resistant *Staphylococcus aureus*.

Step 4: Draft risk communication

Next to addressing all concepts from the expert model on the website (see Figure 1), we intended to fill the detected knowledge gaps and set right the identified misconceptions. We decided to present the risk communication according to a question-and-answer format. Since explicitly stating both the misconception and correction is critical,[7] we formulated the misconceptions as questions and provided the correction in the answer. Table II provides an illustration of how the misconception "MRSA is an illness" was addressed on the website.

In total, 200 questions and answers were formulated covering the concepts from the expert model and eliminating all identified misconceptions. Answers were based on national MRSA guidelines, and were validated, complemented, and actualized by a medical microbiologist involved in the research project.

In order to ensure that the website's content matched the public's vocabulary, we avoided jargon and used words such as "get rid of MRSA" instead of "eradication therapy", "take swabs" instead of "perform screening cultures", "outbreak" rather than "epidemic situation", et cetera. Each question was answered according to a standardized format based on usability guidelines,[12] with important items placed consistently at the top center. Scroll stoppers were avoided as much as possible and moderate white spaces were used. Each answer comprised a title, a short answer, an instructional video, comments, and (scientific) references such as newspaper articles, links to other websites for further reading, and multi-media examples, as depicted in Figure 2. In order to keep information accurate, revision dates and the latest news were included. Furthermore, visual aids such as tables and tree diagrams were added.

In order to help the public find their way around the website, we incorporated three search possibilities (see Figure 2) and allowed the public to rapidly switch from one search strategy to another. We also incorporated a breadcrumb trail to help the public keep track of their location within the website.

Step 5: Evaluate risk communication

Participants of the usability tests were generally positive towards the website. Positive statements mainly concerned the website's relevance, comprehensibility, and usability. The information was perceived as recognizable from daily practice, and respondents could identify themselves with the information. Some illustrating statements:

"I like the idea of this website! I think people know too little about MRSA, which leads to much uncertainty. The website can help in here."

"The use of words really astonishes me: regular language that everybody can understand, from high to low, and I like that."

On the contrary, respondents were slightly negative about the website's accuracy, since some respondents had additional knowledge to the information presented on the website. For instance:

"This is not completely correct. It says: "MRSA infections are treated with an antibiotic, Vancomycin. However, I know that Vancomycin is also used to control colonization, not only infection."

Another problem appeared to be the tone-of-voice: respondents indicated that they sometimes were frightened by the information on the website, as is illustrated by the following example:

"This gives me something of a shock! It is not what I expected as a pig farmer, I expected information about pig MRSA and the home situation but what I find now is: cover wounds, wash hands, I did not realize that."

Furthermore, despite our attempts to avoid use of any medical jargon, the website still included several words that were not understood by the respondents, such as "extramural", and "swabs".

The identified inadequacies were solved before the website was launched online (see www.mrsa-net.nl).

Discussion

To our knowledge, this study has been the first attempt to systematically determine the Dutch general public's beliefs concerning MRSA, providing a starting-point for risk communication strategies in order to inform the general public about MRSA. Because in the Netherlands CA-MRSA is ever more prevailing, education of the general public is of vital importance.

The majority of the little research that has been conducted to determine the public's knowledge concerning MRSA, focused mainly on surgical patients.[13-15] Only one study could be identified that particularly investigated the general public's awareness.[16] Considering the qualitative nature of that study and its broader focus on regular *S. aureus* infections rather than MRSA in particular, the study results might have been too limited to base effective communication strategies upon.

Our own study's main limitation is that the questionnaire data might be biased by the inclusion of a high number of young, high-educated people. Furthermore, we used a convenience sample for the open-ended interviews and usability tests, implying that the respondents' level of knowledge regarding MRSA was possibly higher compared to the rest of the population, which might have biased the results.

Overall, our study showed that the Dutch general public recognizes well-known risk factors and consequences of MRSA. However, misconceptions existed regarding origin, spread, and consequences, and knowledge gaps were found concerning prevention (e.g., importance of hygiene measures) and reservoir (e.g., MRSA mainly manifests on the skin). Some of our results were similar to the results of the aforementioned study, that was conducted in the United States.[16] In both studies, only 33% of the general public were aware of the importance of hygiene measures in order to keep MRSA from spreading, and half of the sample knew MRSA mainly spreads by direct contact and contaminated surfaces. The insect bites as a way of transmission were also mentioned by American respondents. This

might be caused by the fact that MRSA infections are often confused with spider bites.[17] However, although the MRSA-rate is higher in the United States than in the Netherlands,[18] only 22% of American respondents had heard of MRSA before, compared to 62% of the Dutch respondents. This difference might be ascribed to the media coverage of MRSA in the Netherlands in contrast to the United States, although this should be interpreted with caution, because the American study was conducted in July 2005, and since then, American media have been reporting intensively about CA-MRSA.

We developed risk communication based on the public's mental models that we had systematically identified before. We provided the risk communication through a website, incorporating misconceptions raised by the open-ended interviews and questionnaires. We could not have foreseen the misconceptions that respondents came up with, nor their reactions to the draft version of the website. Addressing the most prevailing misconceptions in a question-oriented manner on the website might have led to the comprehensibility of the information, as was proven by the usability tests. However, simply correcting existing misconceptions is not sufficient. It appeared crucial to choose the right communication style that matched the target group's preferences and tacit knowledge, since the usability tests demonstrated that particular words of use evoked feelings of fear, and that words that we considered as common (e.g., "extramural" and "swabs"), were not understood by the general public.

Taking into account the public's mental models and their opinion towards the draft version of the website might have contributed to the website's eventual success, which has been visited by 400 daily unique visitors since its launch in February 2008. Furthermore, it may be that the public's involvement in the design process created ownership, and fostered applicability of the website.

Overall, our findings highlight the need for general efforts to systematically analyze the public's mental models prior to designing risk communication. Therefore, we advocate that before disseminating risk communication, communicators must characterize expert knowledge about the risk, study current beliefs, examine the risk decisions that people face, develop a communication focused on critical content, and evaluate the message through empirical testing. Although the Mental Models Approach is relatively time- and cost-intensive, we assume it is worth the investment since adequate risk communication can save much larger amounts down the road, e.g., when outbreaks of MRSA are prevented since the public performs better personal hygiene.

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