ences and Institute of Transportation Studies, University of California, Irvine, Oct. 1977.
13. J.L. Compton. Public Services--to Charge or Not to Charge? In Cases and Readings for Marketing for Nonprofit Organizations, P. Kotler, O.C. Ferrell, and C. Lamb, eds., Prentice-Hall, Englewood Cliffs, N.J., 1983.
14. W.J. Johnston. Industrial Buying Behavior: A State of the Art Review. Review of Marketing, Oct. 1981, pp. 75-88.
15. M.K. Agarwal, P.C. Burger, and A. Venkatesh. Industrial Consumer Behavior: Toward an Improved Model. Presented at the Academy of Marketing Science Annual Conference, Miami, Fla., May 1981.
16. P.H. Schauer. Marketing for Successful Public Transportation. In Sue F. Knapp, Hannah Worthington, and Jon E. Burkhardt, Wisconsin Manual to Coordinate Elderly and Handicapped Transportation Services in Rural and Small Urban Communities, prepared for the Bureau of Transit, Wisconsin Department of Transportation, Dec. 24, 1980.
17. P. Kotler and S.J. Levy. Broadening the Concept of Marketing. In Cases and Readings for Marketing for Nonprofit Organizations, P. Kotler, O.C. Ferrell, and C. Lamb, eds., Prentice-Hall, Englewood Cliffs, N.J., 1983.

Paratransit and Bus Accidents Involving Elderly and Disabled Passengers: Evacuation and Rescue Problems and Solutions

JOHN N. BALOG and ROBERT J. PAWLAK

ABSTRACT

The provision of efficient and safe methods for the effective evacuation and rescue of elderly or disabled passengers from standard and modified vans, body-on-chassis small buses, and heavy-duty transit buses is necessary to ensure passenger safety. Standard methods are not always effective for these patrons because of their physical or mental condition or their insufficient ability to manage self-evacuation. Effective methods and equipment are identified and developed as a function of transit use by the elderly or disabled, accident incidence types for the various transit vehicles, a study of actual transit vehicle characteristics and their crashworthiness, and an analysis of emergency preparedness forces. Needed equipment is identified and suggestions are made for familiarity and simulation training, development of standard operating procedures, debriefing after actual accident experiences, and sharing technology. An industry-wide project review committee was established to comment on the development of evacuation and rescue scenarios and alternative methods. Transit operators, state departments of transportation, and transit equipment manufacturers were interviewed as part of this U.S. Department of Transportation-sponsored research.

The provision of efficient and safe methods for the effective evacuation and rescue (E&R) of passengers from public transit vehicles is necessary to ensure passenger safety. Methods applicable to the general public, however, may not always be useful in the E&R of elderly or disabled passengers as a result of their physical condition and often of their insufficient agility to manage self-evacuation. The identification, development, and implementation of effective methods for safely evacuating and rescuing such passengers is absolutely necessary and increases in importance as greater accessibility is provided.

The research reported here was sponsored by the Transportation Systems Center and the Urban Mass Transportation Administration (1). The specific goal was to identify and evaluate alternative methods that can be used to ensure the safe and timely E&R of elderly or disabled passengers from standard and modified paratransit vans, body-on-chassis small buses, heavy-duty urban transit buses, and intercity buses. The term elderly and disabled includes any member of the population who is either elderly or handicapped. One does not have to be both elderly and disabled to be part of the population to which this research is directed. Particular concern is assigned to those who, because of age, disability, or age and disability, would find it difficult to escape unaided from an accident involving a public transit vehicle.

An industry-wide project review committee commented on the development of E&R scenarios and on the evaluation of alternative methods, equipment, procedures, and techniques that were identified or developed by this research program.

THE TRANSPORTATION HANDICAPPED

The transportation characteristics of the elderly and disabled population have been extensively studied during the last decade or so (2-4). Much of this work has been concerned with defining a subgroup of the population referred to as the transportation handicapped. Section 16(c) of the Urban Mass Transportation Act of 1964, as amended, defines a transportation handicapped person as

> Any individual who, by reason of illness, injury, age, congenital malfunction, or other permanent or temporary incapacity or disability, is unable without special facilities or special planning or design to utilize mass transportation facilities as effectively as persons who are not so affected.

The transportation handicapped differ considerably in the severity and extent of their disabilities, attitudes toward their physical and mental limitations, income, age, and mobility. Because of these differences, the transportation problems and needs of the transportation handicapped also differ widely.

A variety of mobility problems is experienced by the transportation-handicapped population. A national sample survey (4) of the transportation-handicapped population base of 7.44 million persons studied by UMTA revealed the statistics given in Table 1. One can infer that many transportation-handicapped individuals experience some combination of the eight mobility problems. It is important to realize that any of these problems can negatively affect E&R efforts.

EVACUATION AND RESCUE FROM PARATRANSIT VANS

Paratransit vans are growing in popularity among the elderly and disabled and are providing significant numbers of trips in areas where coordinated or special effort systems exist. The E&R of elderly and disabled passengers from paratransit vans is more difficult than from other highway transit vehicles because the percentage of elderly and disabled passengers in vans is much greater than in full-size transit and intercity buses. This can mean that the only able-bodied occupant of a van that has been involved in an accident is the driver. Even if the driver is uninjured or only slightly injured, he or she may not be capable of single-handedly extracting elderly and disabled passengers from the involved vehicle. The help of properly trained rescue, emergency medical services (EMS), and police personnel will generally be required for non-fire-related incidents. In fire-related emergencies, the passengers and the driver may have to rely on the help and assistance of witnesses, nearby motorists, and other Good Samaritans before professional E&R personnel arrive on the scene.

Vans have become commonplace on the nation's highways and typical emergency response individuals may think they are already familiar with vans. However, in paratransit usage, vans are often equipped to seat as many as 15 individuals, may be modified with lifts and tie-down devices to serve the special needs of the disabled, or may be equipped with a raised roof structure. The passengers are consequently tightly packaged within the vehicle.

The critical problems associated with the E&R of elderly and disabled passengers from vans result from an interaction of the characteristics of the emergency-causing incident (ECI), passengers, vehicles, E&R forces, and modifying factors.

TABLE 1 Incidence of General Mobility Problems Among Transportation Handicapped People

Mobility Problems	Transportation Handicapped With Problem (%)
Difficulty going up or down stairs/inclines	64.9
Difficulty stooping/kneeling/crouching	60.6
Difficulty walking/going more than one block	56.9
Difficulty waiting/standing	56.2
Difficulty lifting or carrying weights up to 10 lbs.	47.3
Difficulty moving in crowds	41.4
Difficulty sitting down or getting up	40.5
Difficulty reaching/handling or grasping	33.5

NOTE: Percents add to more than 100% because of multiple general mobility problems among transportation handicapped people.

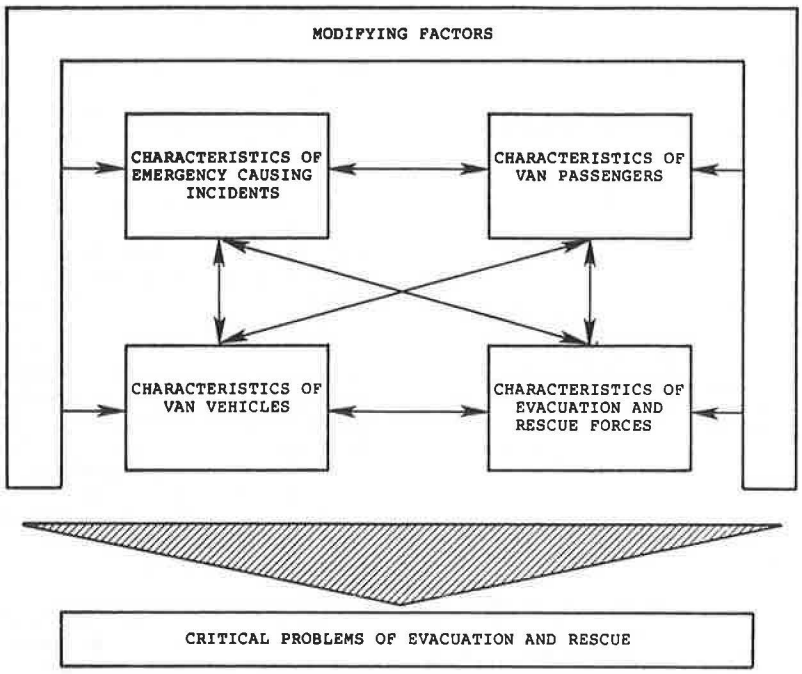

FIGURE 1 Components for developing critical evacuation and rescue problems.

Emergency Characteristics

The interaction of these characteristics in the development of critical E&R problems is shown in Figure 1. An ECI may be any of the following events: driver incapacitation, collision, rollover, fire, water immersion or submersion, or any combination thereof.

Incapacitation of the driver is an interesting ECI. If it happens while the van is in motion, it can lead to 10 combinations of ECIs as shown in Figure 2. Even if incapacitation happens while the vehicle is stopped, an emergency could develop if, for example, the passengers are retarded to the point of not being capable of taking control of the situation; the passengers, perhaps wheelchair users, are disabled to the point that they cannot easily leave the van to seek help; or the senility of the passengers prevents them from taking direct positive action. Figure 2 can also be used to define schematics of other emergencies initiated, respectively, by a collision, a rollover, fire, or water immersion or submersion.

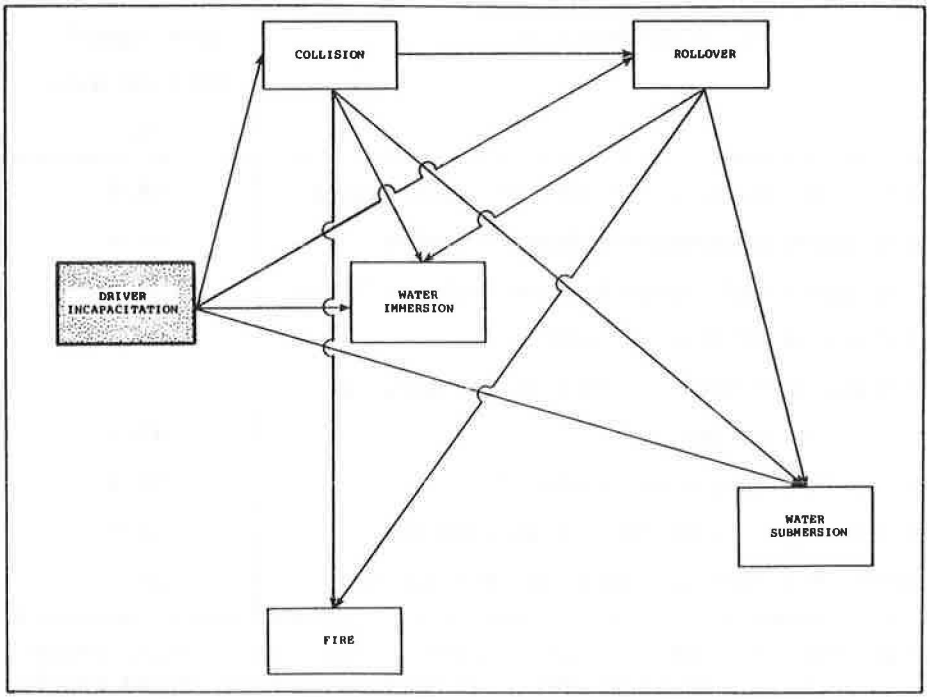

FIGURE 2 Schematic of various emergency-causing incidents initiated by driver incapacitation.

Of the ECIs or combinations thereof, those that involve fire or water immersion or submersion may allow the least time for E&R. If the first evidence of a van fire is smoke, the operator may have time to evacuate all occupants before the vehicle becomes totally involved. Such an evacuation would have to be conducted by the operator in a very physical manner; there probably would not be sufficient time to use a wheelchair lift or ramp. Evacuation should always occur before any effort is made to fight a fire. If the first evidence of a fire is flame, only those most easily assisted would probably have time to escape; a form of triage would occur.

For example, a paratransit association recently experienced an emergency when the engine compartment of a modified van ignited without warning and from an unknown cause. The vehicle was lift equipped and was carrying 11 retarded adults and a driver. When smoke appeared, the driver evacuated the passengers through the right front door. After getting what he thought was everyone off the van, he counted the passengers and found that one was missing. He reentered the vehicle and had to physically remove one passenger who had become immobilized as a result of the emergency. Recognizing that retarded individuals have a tendency to wander off, he told all of them to form a single-file line and to move away from the vehicle. Figure 3 is a photograph of the burned van in a storage yard.

FIGURE 3 Modified paratransit van: fire as the emergency-causing incident.

Submersion in water would probably result in few survivors. Presumably each of the occupants would be initially dazed by the impact with the water and instinctive reactions would govern. With a lift-equipped van, the right side door in most cases would not be functional as an exit. Similarly, the rear door of any van equipped with a full-width rear seat would be difficult at best to use, particularly with the force of the water against it. This would leave only the two cab doors as the most probable exits. The driver side door would be less than ideal for volume escape because of the seat and the position of the steering wheel. The expectation that many passengers would survive a submerged-van accident is minimal.

The outcome of other ECIs (and combinations) can be mitigated to a greater extent because of the probability that some time will be available for E&R and EMS personnel to arrive on the scene and to administer appropriate treatment. However, complex extrication may be required if the van has rolled over. In the accident shown in Figure 4, a council

FIGURE 4 Susanville, California, accident: van in final resting position at accident site.

on aging van was struck on the left front by an opposing pickup truck. Six passengers were killed, and five sustained significant injuries. Two of the injured were pinned in the wreckage. The upside-down orientatin of the van made gaining access to the victims extremely difficult. A crushed roof and van body distortion also contributed to the problems of E&R and the administration of emergency medical services.

Passenger Characteristics

The characteristics of van passengers play an important role in the development of critical E&R problems. In the worst cases, passengers may be only partly mobile, nonambulatory, senile, retarded, blind, deaf, or some combination thereof.

These characteristics can cause the following problems for E&R and EMS personnel during an emergency: Passengers may not be able to effectively communicate; passengers may have preexisting conditions, perhaps medical, that may affect the type of emergency treatment required and the manner of its administration; passengers may become entrapped or impaled by the very aids that generally improve their life experience (e.g., wheelchairs, tie-downs, walkers, crutches, prostheses); passengers may not be rational; passengers may not be able to physically contribute to extrication maneuvers; or passengers may have to be specially packaged before removal from the vehicle and transport to a hospital.

Van Characteristis

The characteristics of paratransit van vehicles also contribute to the development of critical E&R scenarios. For example, they possess a greater propensity than automobiles to overturn and to have doors jam. They are often fully loaded with as many as 15 occupants; they are often equipped with a wheelchair lift device that, in the stored position, can prevent emergency exit through the door in which it is placed (Figure 3 shows a typical blockage); they are often equipped with a full-width rear seat that can prevent easy emergency exit through the rear door; and they may have been modified with a roof structure that has reduced the structural integrity of the vehicle and that allows greater crush penetration into the passenger compartment or contributes to the ease of passenger ejection.

Rescue Worker Characteristics

Also contributory to the development of scenarios of critical E&R problems are the characteristics of the E&R forces. Assuming that all the personnel are appropriately motivated to respond to emergencies in an effective manner, the two relevant characteristic bundles are availability of necessary and appropriate equipment and demonstrated ability to make the best use of all resources as a result of proper education, training, and simulation exercises.

Because most E&R forces currently have only minimal experience with van accidents, perceived basic equipment needs are the result of speculation. Only more experience and the simulated extrication of elderly and disabled passengers from paratransit vans will provide an answer. In any case, this factor can contribute to critical E&R problems.

Definitive statements can be made about education and training. The better educated and trained the E&R force, the more impressive is their performance in an actual emergency. This cannot be overstated. A paratransit van accident is an infrequent occurrence and may require the application of unique and complex techniques. The only way to be prepared is to be familiar with what to expect from the vehicles and with what to expect, or not to expect, from the passengers.

Modifying Factors

The type of ECI and the characteristics of the van vehicle, the passengers, and the E&R forces all interact to form a unique emergency situation. However, there are several modifying factors that can further contribute to the complexity. They include, for example, the time of day of the accident, the day of the week, the location of the accident, and the potential for secondary injuries.

The first three modifying factors can be addressed simultaneously. If the incident is in an urban area, it is probable that it will be identified quickly and that E&R and EMS personnel will be able to reach the scene quickly. In contrast, a rural setting may mean that precious time is lost before a passerby notices the accident, particularly if it is of the off-the-road or water immersion or submersion type, and before E&R personnel can arrive on the scene. Similarly, with time of day and day of week, the response time and the number of respondees may affect both the timeliness and the adequacy of emergency actions and treatment.

With highway vehicles, there is always the potential for secondary injury to passenger victims and for primary injury to rescue forces, other motorists, witnesses, and spectators. Such injuries may be caused by an after-the-accident fire or explosion; involvement of other vehicles with the wreckage, rescue equipment, personnel, or victims; ineffective or improper use of equipment; and inappropriate extrication methods or procedures used on the victims.

Emergency Response Effectiveness

The effectiveness of the E&R of elderly and disabled passengers from paratransit vans is a function of actions in three distinct temporal frames: preaccident, prearrival on-site (after accident), and on-site.

The most effective E&R procedures are founded on the following preaccident actions: the use of quality personnel, the continuing education of personnel, the continuing training and simulation experience of personnel, and the availability of a reasonable quantity of specialized equipment.

Every effort must be made to ensure that the best available personnel are identified and hired for E&R and EMS duties. They must be sensitive, properly motivated, dedicated to the saving of lives and the minimization of injuries, and reasonably intelligent. These carefully selected individuals must be given the opportunity to become fully educated about the frequency of use of paratransit vans by elderly and disabled passengers; the physical, mental, and emotional characteristics of elderly and disabled passengers; the characteristics of the prostheses and orthopedic aids used by elderly and disabled passengers; the characteristics of the paratransit vans, including special modifications, primarily used by elderly and disabled passengers; and the need in most cases to handle and treat elderly and disabled passengers differently than passengers who are not elderly or disabled.

This necessary education is best accomplished by requiring classroom instruction; direct contact with elderly and disabled individuals and the paratransit vehicles they use; and simulations of paratransit van accidents, including collisions, rollovers, fires and water immersion or submersions, using actual or mock elderly and disabled "victims." A single simulation is better than none but the best E&R responses will come from forces that have experienced multiple simulation exercises designed to acquaint personnel with the uniqueness of paratransit vans and elderly and disabled passengers.

It is necessary for the E&R unit to own a basic set of equipment and to be fully familiar, through training and simulation, with its characteristics and capabilities. It is also important to provide simulation training that will encourage personnel to be innovative when necessary to react to unusual or unexpected circumstances.

The effectiveness of E&R procedures is also dependent on the prearrival on-site actions of the emergency preparedness forces. When notice of a van accident is received, it is imperative that the following be obtained in addition to regular information: whether it is a paratransit van; the name of the agency operator (usually on side of van); if the van has rolled over; and the number of occupants of the van.

If it is a paratransit van, it can be immediately assumed that all of the passengers are elderly or disabled and that extrication will require considerable effort. An appropriate, probably large, contingent of E&R and EMS personnel should be dispatched to the scene along with an adequate number of ambulances.

While this contingent is on its way to the scene, the dispatcher or other designated individual should call the agency operator to determine the preexisting medical conditions of the passengers and to associate those conditions with specific individuals. This information should be radioed immediately to the rescue and EMS forces. A representative of the operating agency should also go to the site, if it is within a reasonable distance, to provide assistance and information to the forces and reassurance to the passengers.

When on-site, the E&R and EMS personnel must bring all of their education, training, experience, and capabilities to bear on the problem at hand. This means recognizing the presence of elderly and disabled passengers, assessing their injuries, taking immediate life-saving actions, stabilizing injuries, packaging victims appropriately (it may be necessary to assume fractures to all limbs and spinal injury if para- or quadriplegics are on board), extricating victims from the vehicle, and

transporting them to hospital facilities. This often has to be accomplished without any aid from the injured passengers.

The agency operator of paratransit vans should also help E&R personnel before the occurrence of an accident. It is recommended that all van operators provide the E&R and EMS forces in their service area with the following information: agency name, address, and telephone number; names and telephone numbers of responsible primary and backup officials; description of vehicles in fleet including passenger carrying capacity; characteristics of the passengers most generally transported; and any other information that could be useful to E&R and EMS personnel in the event of an accident.

Each agency should develop an identification card that is carried by each passenger and contains such pertinent information as name and address; date of birth; description of the individual (eye color, height, weight, hair color, and so forth); person to notify in case of emergency (and telphone number); existing medical condition or injuries; unusual characteristics (e.g., senility, retardation, deafness, missing limbs, wheelchair user); and name and telephone number of attending physicians, doctors, and therapists. These client-specific cards should be bound in plastic for durability. The intent of the system is to provide E&R and EMS personnel with specific on-site information about accident victims.

It is also recommended that all paratransit vans be equipped with two-way radios (mounted to be accessible to passengers as well as to the driver) and permanently posted with instructions on how to use them. In the event of an accident or emergency, the driver could call for help. If the driver is incapacitated, a passenger could call for help. If the radio is still operable after an accident, E&R personnel might want to converse directly with the agency about a victim.

Another recommendation is that every paratransit van should bear the name of the sponsoring agency on its side and should have a unique identification number. Again, these measures could speed the flow of critical information to E&R and EMS personnel.

Because there are so few paratransit vans compared with passenger cars, their involvement in an accident is a rare, or even unique, event for rescue and EMS personnel. It is, consequently, imperative that these personnel be fully debriefed about their experiences and that the results be disseminated. Actual experiences could serve as the basis for the development of more effective training programs and simulations, the clarification of what equipment and procedures were appropriate and useful, and the determination of what voids exist and need to be filled. Documentation and full dissemination of such experience would indeed benefit the industry.

EVACUATION AND RESCUE FROM BUSES

As might be expected because of their widespread availability, buses are relied on most frequently by elderly and disabled people. Buses are used by 22 percent of the total elderly and disabled population and provide 41 percent of their trips.

The frequency with which elderly and disabled people will be encountered on a bus is a variable quantity. Historically, a large proportion of transit riders have been the captive transit dependents, which include the elderly. Overall elderly people may have represented 40 percent of all transit riders. However, the temporal distribution is not uniform. The number of elderly passengers is significantly lower during peak hours, which are largely devoted to work-oriented trips, and higher during off-peak service. Consequently, although bus occupancy may be lower during the non-peak period, the proportion of elderly passengers on board may be much higher. Generally, with the exception of some special express bus commuter services, it is probable that there will be elderly passengers on board every bus trip.

The aurally and visually impaired are also frequent users. The deaf and hearing impaired are difficult to recognize but may need special help during an emergency because they would not receive verbal directions unless they were in a position to read lips. The blind person is distinguished by the presence of a cane or a seeing-eye dog. However, currently only about 3 percent of the visually impaired population use dogs.

Although the overall incidence of wheelchair users within the general population is known to be around 0.2 percent, their transit ridership characteristics are not yet defined. Obviously those systems with inaccessible fleets have zero ridership. It must be emphasized that no major metropolitan area has as yet established a fully accessible bus transit system. However, in Seattle, where an overall environmental as well as transportation commitment to accessibility has been made, the rate of wheelchair ridership is approaching that expected from their population incidence and similar trends are evident in some smaller cities such as Johnstown, Pennsylvania (Cambria County Transit Authority) where a high level of accessibility is provided.

Buses may most conveniently be divided into three categories: body-on-chassis and other small buses used in paratransit for elderly and disabled passengers in small cities or rural areas; heavy-duty transit buses designed for long life, low maintenance operation in regular fixed-route transit services; and motor coaches designed for over-the-road intercity service. Buses experience the same ECIs as vans but their large size and weight generally protect passengers. It is apparent, though, that existing methods for E&R of elderly and disabled passengers leave a lot to be desired. Many of the suggestions previously offered in the paratransit van section are also directly related to E&R from buses: familiarity training; equipment training; operational procedures; simulation training; debriefing after accidents; and technology sharing. In this section some of the problems and solutions that are bus-specific will be considered.

Emergency Equipment and Information

Some common emergency equipment is adequate and should be required by operators to be on board. However, it is apparent that some new equipment needs to be developed and implemented by system operators, bus manufacturers, and emergency personnel.

The transit operator should require all purchased buses to be equipped with an appropriate hand-held fire extinguisher and a first-aid kit. Drivers should be trained to initially fight a fire after all passengers have been evacuated and to administer basic first aid. Agency operators of buses should display their names on the sides of their vehicles and provide all relevant emergency information to rescue personnel before the occurrence of an accident. Passenger information should also be available for use by emergency personnel at the time of an accident. Drivers should identify and demonstrate the use of all emergency exits to passengers using a custom-designed procedure.

The manufacturers of buses should recognize that their vehicles could be involved in an emergency in-

cident. Therefore, information on how to get out of the bus, directed to passengers, and information on how to get into the bus, directed to rescue forces, should be displayed. For example, information on the location of emergency exits should be clearly and permanently attached to the interior of the vehicle. Ideally, passengers should have more than one egress option. Information should also be posted on how to open the exit. This is an area where standardization of symbols and location of information is needed. Figures 5 and 6 show positive emergency exit signage and, in the case of the body-on-chassis bus shown in Figure 6, instructions on how to open the exit.

FIGURE 5 Emergency exit signage: school bus fitted for E&H passengers.

FIGURE 6 Emergency exit signage and instructions on a body-on-chassis small bus.

Rescue forces need to know which windows are meant to be used as exits. Generally, buses have no information on their outside that would help emergency personnel or Good Samaritans gain access to the interior of the vehicle. Yet, if a bus turns over on its door side, the only available exits are the windows or the roof escape hatches. With respect to the escape hatch, no information is on the top (outside) of the bus or on its side indicating existence of the hatch. The two most widely used roof escape hatches vary greatly in their design and in ease of opening from the outside.

Information should also be placed on the outside of vehicles about how to open doors. Some intercity coaches are equipped with an outside door opener but no attention is drawn to it by words or symbols. One can appreciate that this is done with the intent of preventing theft and vandalism. However, the goals of access and security could probably both be realized with a clever application. In some ways, this is similar to the universal key concept for rail transit systems.

The final suggestion to manufacturers is the need to produce a reasonably inexpensive, reliable, and effective engine compartment fire suppression system. Several currently exist that are effective in some ways, but improvements could still be made. A suppression system can be the first step in the E&R process associated with a fire incident; and, indeed, such a system could either eliminate the cause of the emergency or provide valuable time.

Emergency forces also need additional equipment for effective use of window exits. If a bus equipped with hinged windows turns on its side or on its roof, the windows, once disengaged, fall by gravity to the side of the bus in newer models or remain vertical and facilitate escape. In contrast, accidents in which the vehicle remains upright and the door is blocked or rendered inoperable require that the emergency exit windows be used. The simple question is how does one keep the window open while EMS personnel and supplies enter the passenger compartment and while injured passengers, some on stretchers or backboards, are removed? Obviously, expandable poles can be used and need to be made available at low cost to emergency forces. In addition to facilitating access, an effective device would prevent a 40- to 80-lb window from falling on a passenger or an emergency worker.

Related to the window exit equipment situation is the need for a short ladder that can be used to reach the windows from the ground if the bus is upright or to reach the side of an overturned bus (Figure 7). This should not be a difficult development problem. A question to be raised is whether such ladders should be carried on the vehicle during revenue service.

FIGURE 7 Urban transit bus accident.

Last, emergency personnel should be creative in their response to an emergency. For example, the author witnessed an accident simulation that included a victim with a spinal injury. The EMS personnel struggled for quite some time trying to place a canvas and stave spinal immobilization device on the victim. In reality, this victim would have probably suffered a great deal during this struggle.

However, it seems apparent that the victim was already in a contoured device, the seat, and it would have been more effective to strap him to the seat and remove the seat from the vehicle.

Learning and Sharing

Every transit system or operator investigates each accident that it experiences to determine whether it was avoidable and to determine disciplinary action. Few systems or operators debrief with the intent of identifying which E&R methods were effective and which were not, what changes should be made to standard operating procedures if they exist, and what modifications should be made to the vehicles or their safety equipment. Yet this is exactly the type of information that needs to be collected. If it were collected, it would be disseminated to all interested individuals and groups and produce a positive educational benefit. For example, the body-on-chassis bus shown in Figure 8, which reportedly rolled over and landed on its side, clearly exhibits a crashworthiness capability of which other operators should be made aware.

FIGURE 8 Body-on-chassis small bus accident.

The sharing of technology associated with the crashworthiness of transit vehicles and the techniques of E&R from them is encouraged. The dissemination of this paper and the complete final report (1) contribute to this goal. Systems and operators are also encouraged to contribute to the identification and development of E&R equipment and techniques. A formal program sponsored by the American Public Transit Association might afford a means of distributing the cost burden among all operators.

SUMMARY

The provision of efficient and safe methods for the effective E&R of elderly and disabled passengers from paratransit vans, body-on-chassis small buses, heavy-duty urban transit, and intercity motor coaches is necessary to ensure passenger safety.

Elderly and disabled individuals can be the majority of passengers on standard and modified paratransit vans and on body-on-chassis small buses. In contrast they are found to lesser degrees on urban transit buses and intercity motor coaches. Their incidence on vans and small buses is expected to increase because of the special-effort services being provided by transit operators. The existing incidence of travel on the remaining kinds of buses is expected to remain constant.

Standard paratransit vans seem to possess sufficient crashworthiness characteristics but appear to be more inclined than automobiles to roll over in accidents. Modified vans, if properly constructed, possess safety characteristics similar to those of standard vans. However, poorly designed raised roof structures, wheelchair lifts that block entrances and that are not effectively counterbalanced, and other poorly accomplished modifications have been proved to reduce the degree of safety associated with some modified vans.

Body-on-chassis small buses, if properly designed and constructed, seem to possess sufficient crashworthiness characteristics but appear to be more inclined than automobiles to roll over in accidents.

Heavy-duty urban transit buses and intercity motor coaches seem to exhibit positive crashworthiness characteristics. The crashworthiness of highway transit vehicles is important because it influences the kind of crush that can be withstood and as a result the amount of entrapment that may occur and the kind of equipment and procedures that must be used for extrication.

Standard automotive E&R techniques serve as a basis for the E&R of elderly and disabled passengers from transit vehicles but are not sufficient in and of themselves. Passengers may be only partially mobile, nonambulatory, senile, retarded, blind, deaf, or some combination thereof. These characteristics cause problems for E&R and EMS personnel. Elderly and disabled passengers may not be able to effectively communicate; they may have preexisting conditions (e.g., medical) that may affect the type of emergency treatment required and its administration; they may become entrapped or impaled by the very aids that improve their life experience; they may not be rational or able to physically contribute to extrication maneuvers; and they may have to be specially packaged before removal from the vehicle and transport to a hospital.

Various identified scenarios of emergency-causing incidents and accident types were determined. Evaluation of the methods and equipment characteristics with respect to these scenarios reveals a number of shortcomings that fall into the following generic categories: familiarity training; equipment training; operational procedures; simulation training; technology sharing; and debriefing after accidents.

There is a definite need for emergency preparedness individuals to become familiar with the characteristics of transit vehicles and the environments in which they operate, and with the characteristics of elderly and disabled passengers. Transit operators need to interface with emergency forces to contribute to preaccident familiarity.

There is a definite need for the development of specific E&R equipment and for creativity on the part of rescue forces in the use of currently available equipment.

There is a definite need for the development and implementation of standard operating procedures for transit operators and for emergency forces. These developments should be accomplished jointly.

There is a definite need for properly designed and conducted simulation training exercises, which occur regularly and which fully involve all relevant parties including actual or mock elderly and disabled passengers.

There is a definite need for the expansion of existing technology-sharing programs to include information on E&R. This will require E&R forces, transit operators, and others within the industry to fully document experiences and to convey this information

to appropriate governmental or industry officials.

Finally, there is a definite need for the debriefing of all personnel involved in transit accidents, which required the E&R of elderly and handicapped passengers, in order to gain additional information on the effectiveness of existing techniques and equipment and to identify newly developed methodologies and equipment. This needs to be done in concert with a technology-sharing program.

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REFERENCES

1. J. Balog et al. Evacuation and Rescue of Elderly and Handicapped Passengers from Paratransit Vans and Buses. Contract DTRS-57-81-00144. Transportation Systems Center and UMTA, U.S. Department of Transportation, May 1983.
2. Crain and Associates. Transportation Problems of the Handicapped, Volume I: The Transportation Handicapped Population, Definition and Counts. Report CA-OG-0092. UMTA, U.S. Department of Transportation, August 1976.
3. R.M. Michaels and N.S. Weiler. Transportation Needs of the Mobility Limited. Northeastern Illinois Planning Commission, Evanston, Ill., 1974.
4. Grey Advertising, Inc. Summary Report of Data From National Survey of Transportation Handicapped People. UMTA, U.S. Department of Transportation, June 1978.

Funding of Demand-Responsive Transportation for the Elderly in Pennsylvania with State Lottery Funds

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ABSTRACT

The funding of demand-responsive transportation has taken a unique turn in Pennsylvania since the passage of Act 101 of 1980. Through Section 406 and a subparagraph of Section 203, funds have been made available for counties to plan, establish, and operate shared-ride demand-responsive transportation systems that are preferentially for the elderly and also open to the general public. Senior citizens age 65 and above ride at 25 percent of the established shared-ride fare, and the balance is paid by the Commonwealth of Pennsylvania through the State Lottery Fund. The general public rides at the regular fare. The lottery funding has provided a stable source of revenue for demand-responsive systems because there is no ceiling on operating funds. The program has strengthened existing providers and enabled new ones to begin service in previously unserved areas, thereby making inexpensive transportation available to hundreds of thousands of elderly individuals. The development and details of the program are reviewed, and its evolution through the first 3 years of operation is summarized. Data on payments and ridership are included, as is a review of the impact that the program has had in its short history: making general public demand-responsive transportation services available in most areas of the state and contributing enormously to the mobility of Pennsylvania's citizens, particularly those in rural areas who had previously had very little public transportation service.

One of the major developments in transportation during the late 1960s and the 1970s was the rapid evolution of shared-ride demand-responsive services. Such services developed as a supplement or alterna-