Current Status of Artificial Heart — From Experimental Studies to Clinical Application —

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Recently, mechanical cardiac assist devices are applied for the incurable cardiogenic shock patients — that are LVAD, BVAD and TAH.

New designed cardiac assist device — sac type of Avcothane-coated PVC blood pumps and driving units controlled by microprocessor — was developed. The candidates of LVAD and BVAD are estimated approximately 2,000 per year in Japan.

Since 1959, TAH animal experiments was started in Tokyo University and 288 days survival of TAH goat was obtained. Until now, 11 TAH animal survived over 6 months in the world and their death are pannus formation, clotting, infection and pump rupture.

The candidates of TAH are estimated about 4,000 per year in Japan. In future, movable (wheel-chair type) or implantable TAH will be developed for the clinical use.


The process of clinical application of artificial heart is shown in the Figure(1).
Cardiogenic shock patient from post-cardiac surgery or myocardial infarction is treated by conventional cardiotherapy such as pharmaceutical.

If the therapy is not effective, veno-arterial pumping or intraaortic balloon pumping is applied.

When the circulatory condition of the patient is not improved, then, left ventricular assist device is utilized. Sometimes, right ventricular assist device is applied for a patient of primary right heart failure.

When the left ventricular assist is not enough to improve the patient's heart function and the blood circulation, then, bi-ventricular assist is started by adding right ventricular assist.

In general, the left or bi-ventricular assist is continued for several days or several weeks.

The last stage is complete heart substitute that are total artificial replacement or heart transplantation.

The Figure(2) shows clinical criteria how to transfer to the next stage of artificial heart application.

Instead of one or two hours veno-arterial pumping, the arterial pressure is less than 80 mmHg, left arterial pressure is more than 20 mmHg and cardiac index is less than 1.9 L/min./m², then, intraaortic balloon pumping is started for the patient.

After two or three hours balloon pumping, arterial pressure is less than 70 mmHg, left arterial pressure is more than 20 mmHg and cardiac index is less 1.5 L/min./m², then, left ventricular assist device is applied for the patient. If the data of the patient are not improved by left ventricular assist, then bi-ventricular assist is started by adding right ventricular assist.

The Figure(3) shows our case of bi-ventricular assist for a patient who did not be cured by veno-arterial pumping with membrane oxygenator and intraaortic balloon pumping.

The Figure(4) shows bi-ventricular cannulation — from left atrium to ascending aorta and from right atrium to pulmonary artery.

The Figure(5) shows the hemodynamics of the patient.

Instead of V-A pumping and balloon pumping, arterial pressure goes down to less 40 mmHg, then left ventricular assist is started.

Significant improvement of blood circulation could not be detected, then bi-ventricular assist is started.

Arterial pressure increased to more than 100 mmHg and left arterial pressure decreased to 20 mmHg.

The well-conditioned circulation was maintained, then right ventricular assist was weaned off after 3 and half hours assist and V-A pumping and balloon pumping were stopped.

After 40 hours of left ventricular assist, improvement of the patient's heart function was shown and weaning of the left ventricular assist was tried, however the trial was unsuccessful and the left ventricular assist was stopped because of progressive shock.

In the clinical application of the ventricular assist devices, the three requirements are necessary that are installation requirement, hospital requirement and clinical application requirement as shown in the Table(1).

In the installation requirement, two blood pumps, connector, driving system, gas pressure source and accessory pipings are necessary.

In the hospital requirement, clinical experiences on cardiac assist devices, such as V-A pumping, balloon pumping or ECMO are
necessary.
Driving pressure sources, monitoring system, ICU and 24 hours staffs are required.
Clinical application requirements are important in the patient criteria. Maintenance of blood circulation is unable by balloon pumping or V-A pumping, however, the cardiac recovery is expected by left or bi-ventricular assist in less than two weeks.
Of the blood pumps, cannulae, appropriate access, shape and size for clinical use are required.
From our animal and clinical experiences, blood flow regulation of bi-ventricular assist is considered to be difficult and that of total artificial heart is rather easy compared with bi-ventricular assist.
Our proposal on bi-ventricular assist control are shown as follows.
The total cardiac output is less than 100 ml/kg/min. and the right ventricular assist should be weaned off as soon as possible.
The most serious problem is how to treat the assist device dependent patient.
We proposed the consensus of patient's family is necessary that the ventricular assist will be stopped in case when the assist is approved as non-effective therapy during the procedure.
Recently, we could develop the devices in our laboratory and I would like to show you the details briefly.
Two blood pumps are sac type and driven by air pressures, two BiJörk-Shiley valves incorporated in a blood pump and two cannulae are connected with a blood pump as shown in the Figure(6).
The material of blood pump and cannulae is polyvinyl chloride paste coated by Avcothane. The Figure(7) shows the driving system for the Figure(6).
The material of blood pumps, cannulae is polyvinyl chloride paste coated by Avcothane. The Figure(7) shows the driving system for clinical use.
This apparatus is sterilized completely in the gas chamber.
The Figure(8) shows the display of right and left pressure, pulse rate, systolic-diastolic ratio.
Synchronization with electrocardiogram is available.
The Table(2) shows the standard specification of this units --- pulse rate, systolic duration, air pressures, air flow, synchronization and power supply.
Any demand of operation and control requirement is available by use of the three microprocessor units incorporated.
The Figure(9) shows remote controller that is sterilized and available to operate by doctors from the surgical field.
Transfer from surgical operation room to ICU is easily possible with DC battery and air bomb.
As the back up system, the special car was constructed to transport the cardiac assist system and the other accessories of monitoring, control and recording units to the medical facilities by direct telephone communication as shown in the Figure(10).
In this present states, many researchers reported to estimate candidates of ventricular assist devices.
The Table(3) shows the candidates estimation on ventricular assist use in Japan.
The estimation was performed from the three fields --- cardiac surgery, coronary care unit and cardiac clinic ---.
In Japan, 20,000 patients per one year are estimated in open heart surgery and coronary by-pass and so and on.
One to two per cent of the cardiac surgery patients are candidates that are 200 to 400 per year. In that cases, term of assist is considered to be short.
In coronary care units, 40,000 patients were treated for one year.
Two to three per cent of the patients in CCU are considered to be candidates that are 800 – 1,200 patients per year.
These candidates will be devided into two categories --- short term and long term use that are 50 to 50 ---.
Therefore, from the CCU group, 400 – 600 patients per year for short and long term ventricular assist are estimated respectively.
In Japanese cardiac clinics, 5,000 patients of severe heart diseases are estimated as the heart transplantation candidates.
Among them, 10 – 20 per cents of patients are calculated as the assist device candidates that are 500 – 1,000 patients per year and long term use.
Therefore, the number of the short term ventricular assist candidates are 600 – 1,000 per year and long term ones are 900 – 1,600. Therefore, total number of ventricular assist candidates are 1,500 – 2,600 per year in Japan.
Next problem is total artificial heart application in clinical use.
Since 1960, total artificial heart(TAH) research has been started in Tokyo University utilizing dogs, rabbits, sheep and calfs.
In 1972, experimental animal changed to goat that has been used until now as the excellent animal for artificial heart studies.
In 1980, the long survival of goats of 288 days, 243 days and 232 days were recorded in our laboratory. The 288 days is the longest survival of TAH animal experiment recorded in our laboratory. The 288 days is the longest survival of TAH animal experiment in the world as shown in the Figure(11).
The Table(4) shows eleven cases of the total artificial heart animals survived over six months in the world.
Six Utah, three Tokyo, one Berlin and one Hershey.
The blood pump materials are biomer, Avcothane and pellethane. In some cases, anticoagulants are used such as heparin, coumadin, aspirine and persantine.
The causes of deaths are pannus formation, clotting and embolie, blood pump rupture, infection so and on.
The Table(5) shows the pathophysiology of total artificial heart circulation.
In general, hematocrit decrease, central venous pressure increase, circulatory blood volume increase, blood enzymes level increase or decrease infection could be observed in the long survivals.
The most serious problems are pannus formation and clotting and embolie. For the measure, research on antithrombogenic and biocompatible materials, and pump design should be continued further.

The Table(6) shows clinical application of total artificial heart --- the types, duration, method and present feasibility ----.

Applications of total artificial hearts are classified into four types --- transient (less one day), short term (less one month), long term (2 years), and permanent (more than five years).

For transient and short term use, our bi-ventricular bypass method will be applied and the present feasibility of the method will be positively estimated.

However, for long term application, wheelchair type and wearable type of artificial heart will be used. In that time, mechanical or hydraulic driven type will be used instead of air driven type.

For permanent application of total artificial heart, implantable type will be appreciated.

The Table(7) shows the applied clinical fields and problems to be solved in clinical use.

The transient use will be applied for a clinical case whose heart is resected, repaired outside of body and re-implant into the patient.

The short term use will be applied to almost 100 per cent bi-ventricular assist and to transfer to heart transplantation.

The long term or permanent use will be applied to the patient needed total cardiac substitution.

The Figure(12) shows the scheme of future on clinical application of the total artificial heart.

The right collar is animal experiment and the left one is clinical application.

The upper-left application will be realized in the present state.

The middle left, wheelchair type will be realized until 1985.

The bottom left, implantable type will be realized in 2,000.

We, artificial heart researchers are confronting to overcome difficulties how to advance from the possible stage of short term to the next stage of long term use.

The Table(8) shows the technological problems to be solved for the purpose.

For this purpose, wearable or implantable type of artificial heart should be developed in future.

For the blood pump, miniaturization, fitness, implant location, antithrombogenicity, durability and new designed valve have to be studied.

In order to miniaturize the hardware, the driving mechanism will be changed from air driven to mechanical or fluid driven.

For the management on patients, monitoring and control methodology are indispensably necessary.

Further development on the wearable, rechargeable and implantable energies will be important.

Now, I would like to forecast how many patients are estimated for total artificial heart candidates in Japan.

The number of candidates that was estimated by the NIH calculation formula is around 15,000 per year as shown in the Table(9).

If, the candidates are limited under 65 ages, the number is around 4,000 per year as shown in the Table(10).

As the operation cost of total artificial heart is estimated to be 50,000 U.S. dollars per patient per year.

Then, the national operational costs of artificial heart are 44 billion yen to 165 billion yen.

In order to apply the implantable artificial heart in human in future, natural heart resection will be necessary. Goat is excellent animal for artificial heart research, however it has been considered that the use of pump oxygenator is impossible in goat's experiment.

Therefore, in our laboratory, challenges on total artificial heart replacement in goat to use pump oxygenator and resect natural heart have been carried out since 1981. Until now, a goat survived for two months.
Figure (1) Process of clinical application of artificial heart

Cardiogenic Shock (Myocardial Infarction, etc.)

Pharmaceutical Therapy

Veno-arterial Pumping (Oxygenator)

Art. P. > 80 mmHg
Left Atr. P. < 20 mmHg
CI > 1.9 L/min./m²

1 - 2 hrs.

No

IABP

2 - 3 hrs.

A P > 70 mmHg
LAP < 20 mmHg
CI > 1.5 L/min./m²

Yes

IABP Continue

A P > 80 mmHg
LAP < 20 mmHg
CI > 1.9 L/min./m²

Wean off

No

Left Ventricular Assist Device

A P > 70 mmHg
LAP < 20 mmHg
CI > 1.5 L/min./m²

Yes

Bi-ventricular Assist Device

No

Heart Transplantation

Total Artificial Replacement

Permanent

Figure (2) Clinical application criteria to transfer from IABM to total artificial heart

"Post-cardiac Surgery
"Myocardial Infarction etc."
Figure (3) General view of clinical application of bi-ventricular assist device in Mitsui Hospital.

Figure (4) The four cannulation of left and right assist heart pumps through the sternotomized wound of the patient.

Figure (5) The clinical course of the bi-ventricular assist patient.
Table 1: Requirements for clinical application of ventricular assist devices

A. Installation Requirement

1) Two blood pumps (left and right side)
2) Connector for clinical use
3) AH driving system
4) Gas pressure sources (positive and negative)
5) Accessory pipings

B. Hospital Requirement

1) Clinical experiences on cardiac assist devices (IABP, V-A bypass, ECMO, etc.)
2) Driving pressure sources
   Positive air pressure
   Emergent electric resource
3) Monitoring system
   (ECG, blood pressure, blood flow, blood gas and chemical analysis, etc.)
4) ICU
5) 24 hours staffs
   (Anesthesiologist, cardiac surgeon, cardiologist, nurse, clinical engineer)

C. Clinical Application Requirement

1) Patient criteria
   Circulatory maintenance is unable by IABP or V-A bypass, however the cardiac (function) recovery is expected by LVAD or BVAD in less than two weeks.
2) Blood pumps and cannulae
   Appropriate access and shape & size.
3) Blood flow control of bi-ventricular bypass
   a) Cardiac output is less than 100ml/Kg/min.
   b) Wean-off of RVAD as soon as possible.
4) LVAD or BVAD dependent patient
   Consensus of patient's family is necessary that the cardiac assist will be stopped in case when the assist become non-effective.

Figure 6: Blood pump and inlet and outlet cannulae

Figure 7: Front view of driving system and remote controller
Table (2) STANDARD SPECIFICATION OF DRIVING & CONTROL UNIT

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse rate</td>
<td>30 ~ 250 1/min</td>
<td>Synchronizing delay</td>
</tr>
<tr>
<td>Systolic duration</td>
<td>20 ~ 90 %</td>
<td>0 ~ 999 msec</td>
</tr>
<tr>
<td>Air pressure</td>
<td>Left -150 ~ +300 mmHg</td>
<td>mask: 1/1, 1/2, ..., 1/9</td>
</tr>
<tr>
<td></td>
<td>Right -100 ~ +150 mmHg</td>
<td>Power: AC100 ~ 130 V, 7 A</td>
</tr>
<tr>
<td>Air flow</td>
<td>18 1/min</td>
<td>(backed up by the battery and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the compressed airtank)</td>
</tr>
</tbody>
</table>

* Limited only by power supply
* Special Specification will be performed by software changing

Figure (9) Remote control unit

Figure (10) The back up car for cardiac assist devices
Table (3) Estimation on Candidates for Ventricular Assist Device (VAD) in Japan

1) **Cardiac Surgery** (Open Heart Surgery, Coronary By-pass, etc.)
   - **Patients**: 20,000/Year
   - **Candidate Ratio**: 1 ~ 2%  
     \[ 20,000 \times 1-2\% = 200 ~ 400/Year \]
   - **VAD Term**: Short

2) **Coronary Care Unit**
   - **Patients**: 40,000/Year
   - **Candidate Ratio**: 2 ~ 3%  
     \[ 40,000 \times 2-3\% = 800 ~ 1,200/Year \]
   - **VAD Term**: Short and Long  
     (50 : 50)

3) **Heart Transplantation Candidates in Cardiac Clinics**
   - **Patients**: 5,000/Year
   - **Candidates Ratio**: 10 ~ 20%  
     \[ 5,000 \times 10-20\% = 500 ~ 1,000/Year \]
   - **VAD Term**: Long

Total No.
- Short Term VAD = 600 ~ 1,000
- Long Term VAD = 900 ~ 1,600
- 1,500 ~ 2,600

![Fig. (11) Comparison of the Longest Survival in Total Artificial Heart Replacement in the World (March, 1981)](image-url)
### Table 4: TAH Animals Survived Over 6 Months in the World (May, 1981)

<table>
<thead>
<tr>
<th>Facility</th>
<th>Animal</th>
<th>Survival Days</th>
<th>Blood Pump Type</th>
<th>Material</th>
<th>Valve</th>
<th>Anticoagulant</th>
<th>Cause of Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tokyo Univ.</td>
<td>Goat</td>
<td>288</td>
<td>Sac</td>
<td>Arothene/Arov+Polyurethane</td>
<td>BS</td>
<td>None</td>
<td>Human accident</td>
</tr>
<tr>
<td>Utah Univ.</td>
<td>Calf</td>
<td>268</td>
<td>Js</td>
<td>Biomier</td>
<td>HS/BS Nat</td>
<td>Persantine, Asprin</td>
<td>Left heart failure</td>
</tr>
<tr>
<td>Tokyo Univ.</td>
<td>Goat</td>
<td>243</td>
<td>Sac</td>
<td>Polyurethane</td>
<td>BS</td>
<td>Heparin (68-243)</td>
<td>Pannus, Reoperation</td>
</tr>
<tr>
<td>Tokyo Univ.</td>
<td>Goat</td>
<td>232</td>
<td>Sac</td>
<td>Polyurethane</td>
<td>BS</td>
<td>None</td>
<td>Peripheral circulatory, Insufficiency</td>
</tr>
<tr>
<td>Utah Univ.</td>
<td>Calf</td>
<td>221</td>
<td>Js</td>
<td>Biomier</td>
<td>BS/Na</td>
<td>Coumadin, Aspirin</td>
<td>Pannus, GI-bleeding</td>
</tr>
<tr>
<td>Utah Univ.</td>
<td>Calf</td>
<td>217</td>
<td>Js</td>
<td>Biomier</td>
<td>BS/Na</td>
<td>Coumadin</td>
<td>?</td>
</tr>
<tr>
<td>Utah Univ.</td>
<td>Calf</td>
<td>210</td>
<td>Js</td>
<td>Biomier</td>
<td>BS/Na</td>
<td>None (?)</td>
<td>Sepsis, Pannus</td>
</tr>
<tr>
<td>Berlin Univ.</td>
<td>Calf</td>
<td>194</td>
<td>Diaphragm</td>
<td>Pellethane</td>
<td>BS</td>
<td>?</td>
<td>Rupture of blood pump</td>
</tr>
<tr>
<td>Hershey Medical Center</td>
<td>Calf</td>
<td>190</td>
<td>Diaphragm</td>
<td>Biomier</td>
<td>BS</td>
<td>Coumadin</td>
<td>?</td>
</tr>
<tr>
<td>Utah Univ.</td>
<td>Calf</td>
<td>184</td>
<td>Js</td>
<td>Biomier</td>
<td>BS/Na</td>
<td>Persantine, Coumadin, Aspirin</td>
<td>Pannus, Reoperation</td>
</tr>
<tr>
<td>Utah Univ.</td>
<td>Calf</td>
<td>183</td>
<td>Js</td>
<td>Biomier</td>
<td>BS/Na</td>
<td>Persantine, Coumadin, Aspirin</td>
<td>Lung edema, Hemiplegia, Pannus (Accident)</td>
</tr>
</tbody>
</table>

### Table 5: Pathophysiology of TAH Circulation

1. **Ht ↓**
   - Insufficiency of Blood Pump Function (Pump Design)
2. **CVP ↑**
   - Inappropriate Cardiac Output
   - Small Atrial Syndrome
3. **Circulatory Blood Volume ↑**
   - Obstruction of Inflow Connection
4. **Blood Enzymes Level ↓**
   - Increase of Body Weight
   - Hyperadrenergic
5. **Infection**
   - Artificial Chest Wall (Connector)
   - Postoperative Management
6. **Thrombo-embolism & Pannus Formation**
   - Material & Pharmaceutics
   - Pump Design
7. **AH Function Response for Loading**
   - Controll of AH Driving

### Table 6: Clinical Application of TAH (I)
--- Type, Duration, Method and Present Possibility ---

<table>
<thead>
<tr>
<th>Type</th>
<th>Duration</th>
<th>Method</th>
<th>Present Possibility on Clinical Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transient</td>
<td>&lt;1 day</td>
<td>Biventricular bypass type</td>
<td>OK</td>
</tr>
<tr>
<td>Short Term</td>
<td>Survival days to 1 month</td>
<td>Biventricular bypass type</td>
<td>OK</td>
</tr>
<tr>
<td>Long Term</td>
<td>2 years</td>
<td>1) Wheel chair type 2) Wearable type (Air driven, mechanical driven, etc.)</td>
<td>Possible</td>
</tr>
<tr>
<td>Permanent</td>
<td>&gt;5 years</td>
<td>Implantable type</td>
<td>Future</td>
</tr>
<tr>
<td>Type</td>
<td>Duration</td>
<td>Applied Fields</td>
<td>Problems to be Solved</td>
</tr>
<tr>
<td>--------------</td>
<td>----------------</td>
<td>----------------------------------------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>Transient</td>
<td>&lt; 1 day</td>
<td>To resect patient's heart, restore and reimplant it in the patient</td>
<td>None</td>
</tr>
<tr>
<td>Short Term</td>
<td>Survival days to 1 month</td>
<td>1) Biventricular assist (almost 100%) 2) To transfer to heart transplantation</td>
<td>1) Access approach to patient 2) Blood pump and cannulae</td>
</tr>
<tr>
<td>Long Term</td>
<td>2 years</td>
<td>Total substitution of cardiac functions</td>
<td>1) High probability of over 6 months survivals in animal experiment a) Antithrombogenic material b) Reliability, durability and safety of hardware c) Control software 2) Patient monitoring and management</td>
</tr>
<tr>
<td>Permanent</td>
<td>&gt; 5 years</td>
<td>Total replacement of heart</td>
<td>Furthermore, 1) Implantable energy source</td>
</tr>
</tbody>
</table>

Figure(12) Present, near future and far future of total artificial heart (from top to bottom --- present, near future and far future)
Table(8) Technological Problems to be Solved in Transfer from Short Term Use to Long Term Use of TAH

1) TAH System
   Para corporeal or Extracorporeal ➔ Wearable or Implantable

2) Blood Pump
   1) Miniaturization of size
   2) Fittness of shape
   3) Implant location
   4) Antithrombogenesis
   5) Durability
   6) New valve for AH use

3) Driving Mechanism
   1) Air Driven ➔ Mechanical driven, fluid driven (Controllability)

4) Monitoring & Control
   1) Telemetering utilizing microtransducer
   2) Microprocessor incorporate
   3) Analysis on haemodynamics and metabolism in physiological and non-physiological condition. ➔ Control software on TAH
   4) Patient monitoring and management

5) Energy Source
   1) Wearable
   2) Rechargeable
   3) Implantable

Table(9) Estimated Candidates for TAH Replacement in Cardiac Patients in Japan (1979)

<table>
<thead>
<tr>
<th>Heart Disease</th>
<th>No. of Cardiac Death in 1979</th>
<th>Candidates on TAH</th>
<th>upper limit</th>
<th>under limit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Coronary</td>
<td>44,344</td>
<td>16.8</td>
<td>7,449</td>
<td>3.8</td>
</tr>
<tr>
<td>Hypertensive</td>
<td>16,143</td>
<td>5.0</td>
<td>807</td>
<td>5.0</td>
</tr>
<tr>
<td>Rheumatic</td>
<td>1,916</td>
<td>10.0</td>
<td>191</td>
<td>25.0</td>
</tr>
<tr>
<td>Congenital</td>
<td>3,550</td>
<td>25.0</td>
<td>887</td>
<td>25.0</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>62,274</td>
<td>15.0</td>
<td>9,341</td>
<td>15.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>128,227</td>
<td>18.75</td>
<td>12,815</td>
<td>12,815</td>
</tr>
</tbody>
</table>

Table(10) Estimated Candidates for TAH Replacement in Cardiac Patients (under 65) in Japan (1979)

<table>
<thead>
<tr>
<th>Heart Disease</th>
<th>No. of Cardiac Death under 65 years in 1979</th>
<th>Candidates on TAH</th>
<th>upper limit</th>
<th>under limit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Coronary</td>
<td>9,368</td>
<td>16.4</td>
<td>1,536</td>
<td>3.8</td>
</tr>
<tr>
<td>Hypertensive</td>
<td>1,341</td>
<td>5.0</td>
<td>67</td>
<td>5.0</td>
</tr>
<tr>
<td>Rheumatic</td>
<td>1,135</td>
<td>10.0</td>
<td>113</td>
<td>5.0</td>
</tr>
<tr>
<td>Congenital</td>
<td>3,550</td>
<td>25.0</td>
<td>887</td>
<td>25.0</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>15,454</td>
<td>15.0</td>
<td>2,318</td>
<td>15.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>30,848</td>
<td>4,921</td>
<td>3,683</td>
<td></td>
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