Some reflections on the functioning and results of the Lion incubators during the National Exhibition

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Visitors to the Exhibition all noticed the pavilion housing the infant incubators, which had been installed by the firm of A. Lion of Paris to make its apparatus known. Having been charged by this firm with the medical supervision of the establishment for the duration of the Exhibition, I should like to share a few reflections suggested to me by these five months of activity.

I shall not embark here on a long dissertation on the incubator for infants born before term; this is a subject that has become classic and perfectly familiar to all practitioners, and the literature on it is moreover very rich, dating back to Tarnier's first communications in 1880.

Every Maternity ward now possesses apparatus of greater or lesser quality of construction, more or less easy to operate. It is precisely the enormous difficulty one almost always encounters in obtaining a constant regulation of temperature, together with sufficient ventilation, that is the almost sole source of the numerous failures in the brooding of babies. At the Exhibition one could see that with the Lion incubators these drawbacks disappear, and I will recall in a few words the construction and functioning of this apparatus (see the figures opposite).

The incubator consists of a metal parallelepiped mounted on an iron support; its height is 70 cm, and its square base measures 55 cm per side. The front face is fitted with a glazed frame with two leaves, closing by a cremone bolt. The base, D, slides and can be removed, sliding along its grooves like the tray of a birdcage. All the parts being metallic, the entire incubator can be placed, without deterioration, in the disinfection oven using steam under pressure.

Ventilation is ensured by a tube, T, 8 cm in diameter, opening at the bottom of one of the sides of the apparatus, along which one may place a wet sponge to ensure humidity of the air, and a layer of cotton wool to filter it.

Vitiated air escapes through a vertical chimney, C, fitted to the ceiling of the incubator. A propeller working at the top of this chimney indicates, by the speed of its rotation, the strength of the air current.

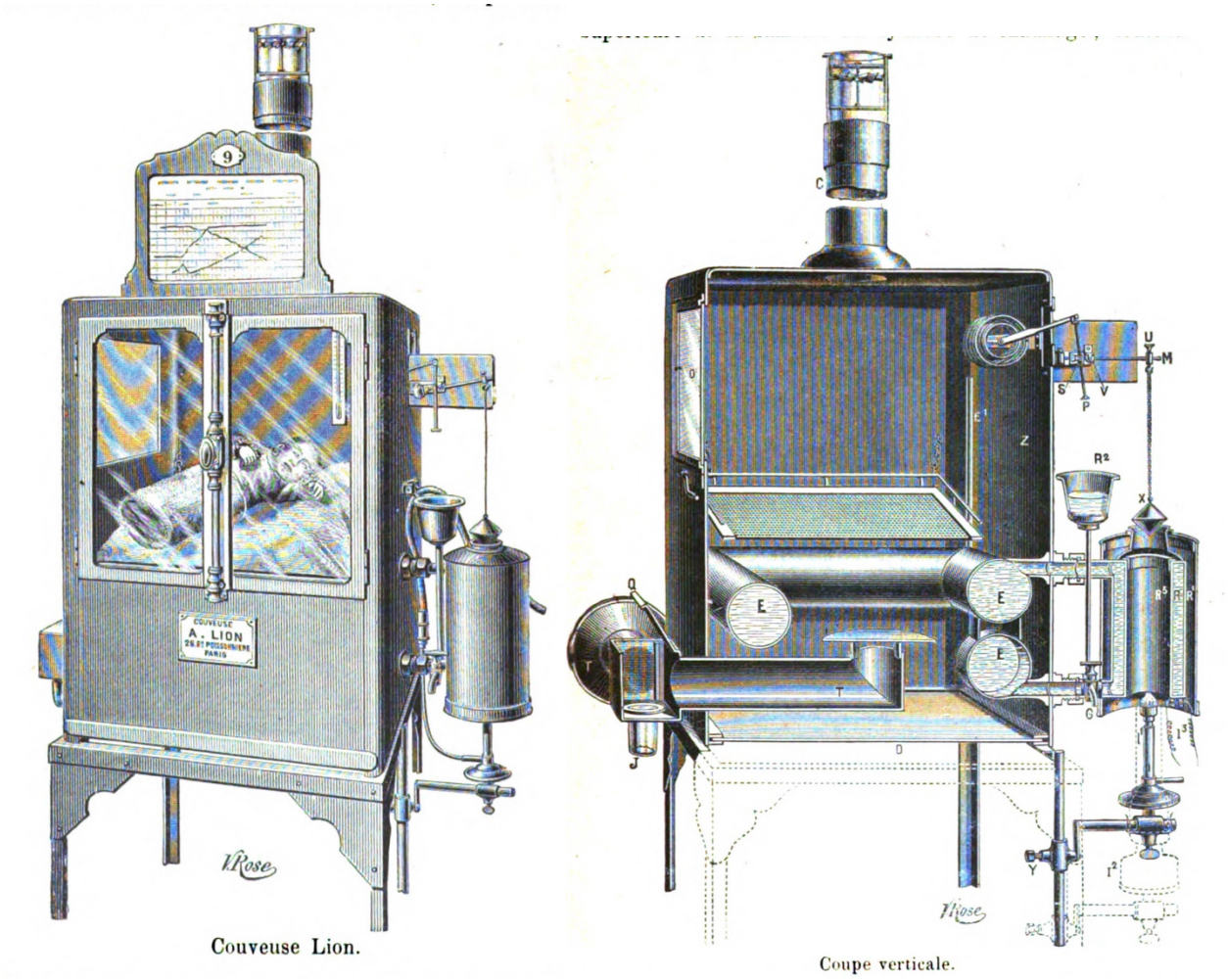
But the most original part of this incubator is its heating and the regulation of its temperature.

A coil, E, 8 cm in diameter, runs around the base of the apparatus; at its upper and its lower (declining) part it connects with a hollow vertical cylinder, R, placed to the right and outside the incubator proper.

This assembly constitutes a thermosiphon that is heated by a burner, I, of gas or petroleum placed in the flue, R^3, of the hollow cylinder; the water in the cylinder is heated, passes into the coil of the incubator, which it traverses from top to bottom while cooling slowly, and the coolest portions are drawn back into the heating cylinder by that same heating action.

Regulation is not obtained—as in bacteriological ovens with a mercury regulator—by supplying more or less fuel; rather, the fuel remaining fixed, it is obtained by a stronger or weaker air current in the flue of the heating cylinder. To this end, a hollow metallic thermometer, resembling in its mechanism an air manometer, is placed inside the incubator, toward its upper part. The greater or lesser expansion of the air contained in the metal spiral acts on a lever, M, which supports a shutter, X; when the temperature falls, this shutter comes to rest on the upper part of the flue of the heating cylinder; all the heat of the burner is then employed in heating the water of the thermosiphon, whose temperature rises, which in turn raises that of the interior of the incubator. When this reaches the desired degree, the lever acts on the shutter, whose rising sets up in the heating flue an air current that carries off part of the burner's heat.

A screw, P, allows the lever to be lengthened or shortened at will, so as to obtain either a rise or a fall of the temperature to the desired degree.



[Figure captions: "Lion Incubator" and "Vertical section."]

This regulation is extremely precise, and if the incubator remains closed, the internal temperature variations never exceed half a degree, as I have been able to satisfy myself many times. It has two precious advantages over mercury regulators: (1) the burner need not be a gas flame—and at the Berlin Exhibition this summer the incubators were heated by petroleum lamps known as "Congo" lamps; the apparatus can therefore operate anywhere, even in apartments without a gas-lighting supply; (2) the

gas flame is subject to no abrupt variation—it always burns at full flame and thus never risks going out; (3) its entirely metallic construction makes it far less delicate and less fragile than any other regulator in which glass may break and liquids spill. The baby itself is carried on a metallic hammock isolated on all sides, and warm air circulates freely around it; the front and side windows allow it to be observed at any moment.

We therefore have here an apparatus with powerful ventilation and an absolutely constant temperature, whose regulation is extremely easy and requires virtually no supervision once set going.

I do not believe that in this respect one could find anything better, and the baby born before term and placed inside will truly have nothing to regret but its umbilical circulation—but the improvements of modern industry have not yet gone so far as to restore that to it.

To make up as far as possible for this last desideratum, there is still nothing but a good wet-nurse, and this is what I have striven to provide to our boarders this summer. But in its debilitated state, the premature infant often lacks the strength to nurse by itself, and one is obliged to resort to tube-feeding. We did this with an instrument far simpler and more easily kept aseptic than the sound and funnel can be. The apparatus we used—also devised by M. Lion—is an ordinary coffee spoon whose tip has the shape of a spout a few millimeters in diameter, which can be introduced into one of the nostrils. The nurse fills the spoon by expressing her breast and gently pours the contents into the baby's nostril; however weak it may be, the baby always swallows without choking. One can thus wait quietly until it has the strength needed to nurse by itself.

The temperature of the incubator will naturally be set according to the degree of chilling and the debility of the infant: in general it is set on the first day to 34°. The next day it may be raised to 35°, if the baby's condition seems to call for it; as its strength increases one may then progressively lower it to 33°, 32°, 30°, and 28°, so as to accustom the child little by little to the ambient temperature.

Let us now consider the results obtained. A synoptic table at the end of this work gives the summary of each observation.

The number of cases treated during the Exhibition is far too small to establish an exact statistic, but it is amply sufficient to give an idea of the value of incubation.

As for lovers of figures, I refer them to a very complete study published last year[1] by Dr. Ciaudo, who was able to observe 185 cases treated at the Lion Maternity in Nice from October 1891 to December 1894. Of these 185 infants, 8 weighing under one kilogram all died; as for the others, deducting 11 cases that died the very day of their admission to the incubator, they yielded 82% survival, which is assuredly a surprising result.

As a curiosity, I will further cite the case of an infant observed last year in Bordeaux, who, weighing only 725 grams at birth, left the incubator five months later in perfect health, weighing 3 kg 300 g.

At Geneva we received 22 infants and observed one case at home. But I will deduct from this number one baby born at term, brought in on account of its congenital debility and returned to its family in good health; one baby born at seven and a half months, who had to be sent back once it was found, on the second day, to be affected with vulvitis that seemed to us infectious in nature; and one baby born at seven months, brought to us in extremis only a month after its birth, who died a few days after admission. There remain twenty infants, born before term, who spent a certain time in the incubators.

Four of them weighed under 1500 grams (Obs. 1 to 4); of these, one girl weighing 1010 grams and born at six months died on the fourth day. Two others, weighing 1320 and 1330 grams and born at twenty-eight and twenty-nine weeks of gestation, are still living and both in very good health at present. The last was a twin who weighed 1440 grams at birth on 25 June and who, on 26 October—although bottle-fed since 14 September—already weighed 3080 grams.

We had to care for nine babies weighing from 1500 to 2000 grams (Obs. 5 to 13); five of them left the incubators in good health after a stay varying from seven to twelve weeks; one of them left alive but, being the child of a tubercular mother who died fifteen days after her confinement, succumbed at the Hospital for Sick Children at the age of three months, seven weeks after leaving the incubators. Finally, three infants died: two on the seventh and fourteenth days, of congenital weakness; the last after 26 days, of bronchopneumonia following a foot wound produced by an obstetric maneuver.

Six infants were admitted with weights varying from 2000 to 2500 grams (Obs. 14 to 19); two of them died the day after birth, the four others left in perfect health.

One infant weighing 2780 grams (Obs. 20) left in good condition; it is very well at present.

As for the later fate of the fourteen infants who left alive, we were able to obtain in recent days information on twelve of them: nine are on a good path to thriving; three have died. One of these is the hereditarily-tubercular child mentioned above, who died at three months (Obs. 11); another (Obs. 13), several weeks after leaving the incubators—which he had left thriving—succumbed to cholerine, which appears due to varied soups having been substituted in his diet for the sterilized milk I had recommended. Finally the last (Obs. 17), who had also left the incubators in excellent health, was afterward placed in the worst hygienic conditions of environment and nourishment, and we learned of his death some time later.

All in all, the overall picture of these results is very satisfactory, especially considering that most of the families who entrusted their children to us belong to the least well-off class of our population.

In the majority of cases, the infant was already cyanotic and chilled when brought to us; it was therefore doomed to certain death. Twice, our thermometer—which registered temperature only from 34° upward—did not even rise that far; yet the next day it registered 36.1° and 37.2° in these same infants. Three times, likewise, the temperature was found to be between 34° and 35°; same rapid rewarming after a few hours in the incubator—all the more so for the other infants whose entry temperature ranged between 35° and 36.5°. It is therefore of the utmost importance to be able to place a premature infant in the incubator as soon as possible after birth. Nevertheless, however brief the period of chilling may have been, I do not believe it harmless; thus on 12 August an infant was brought to us weighing 1970 grams and born eighteen hours earlier; delivery had been by version, and one foot bore a wound produced by a snare that had served for traction. By the next day a bronchopneumonia declared itself, which carried the child off after three weeks of fever; the initial temperature was 34.6°. Who can say whether, placed in the incubator immediately instead of after eighteen hours, this child might not have survived, and whether the bronchi had not been particularly predisposed to invasion by septic germs by this prolonged chilling?

The weight of premature infants undergoes broadly the same variations as that of infants born at term, but the physiological loss of the first days is proportionally greater, the return to the original weight is longer, and the rise of the curve is less marked in the first months than in a term infant—and above all than it would be had the baby remained in the maternal uterus the requisite time.

For infants under two kilograms, the initial loss varied between 30 and 270 grams, with a mean of 123 grams; it lasted from three to sixteen days (mean, eleven days), and the original weight was recovered, depending on the case, between fifteen and thirty-two days (mean, twenty-two days). From the weight minimum, the daily gain varied between 9.4 g and 20.9 g, with a mean of 15.8 g. The birth weight was recovered, depending on the case, in nine to thirty-four days (mean, twenty days).

Despite all the attention we brought to it, it was impossible for us to prevent the admission of babies affected with contagious diseases; we have just cited a case of bronchopneumonia; we also had cases of ophthalmia of the newborn and one of apparently infectious vulvitis. Thanks to rigorous precautions, we had no case of contagion to deplore; but this is why, in future, we would infinitely prefer to see incubators installed in each case at home, rather than provoke at Geneva the creation of an artificial maternity ward.

Other reasons, very powerful in my view, also militate in favor of this way of seeing things. In an artificial maternity ward, premature infants can be provided with excellent hygienic conditions, choice wet-nurses, competent supervision at all times; the babies thrive there wonderfully—but meanwhile the mother loses her milk, and when her baby is returned to her she will be obliged to bottle-feed it if she cannot bear the cost of a wet-nurse. Now, if a baby ever needs prolonged breastfeeding, it is when it is born before term; it is one of the only chances it has of making up lost time.

If, from birth, an incubator is installed beside the mother's bed, she will be able to let the child benefit from her milk; and in the transition period between the child's first outing and the definitive abandonment of the incubator, she will be able to take it out into the open air, expose it to the sun, take it walking—which is naturally impossible in an establishment where several babies demand the continuous care of a necessarily limited staff.

Moreover, the incubator is very easy to install at home, and if the family is willing not to touch the regulating apparatus and to leave this care to the physician, it will function automatically without a hitch. The experiment is carried out daily in Paris, where twenty incubators are at the public's disposal and where, up to now, no accident has ever had to be deplored. Here at Geneva, one incubator functioned for three months in a private home without anyone having had to touch the heating and regulating apparatus for a single minute.

If there is no gas supply, a simple petroleum lamp or an alcohol lamp will suffice, and the only task will be to renew the fuel as it is used up.

As for the care the baby itself requires, since it differs very little from what every newborn needs, family members—well supervised by the physician or the midwife—will fulfill the required conditions just as well as the staff of an artificial maternity ward; and if tube-feeding must be done, the mother or the nurse-attendant will learn it as quickly as our Savoyard wet-nurses, who practiced it unaided from the day after their admission to the incubator establishment.

The incubator being therefore an indispensable instrument in many cases, it is good to know that one has at one's disposal a practical, clean instrument, easy to handle, which will relegate to museums of antiquities those heavy wooden crates with hot-water bottles in which children risked, despite everything, being exposed to greater temperature variations than if they had been exposed to the open air; the archives of maternity wards alone could tell us the number of those who were frozen or scalded there—and even then!

Translator's notes

At Obs. 4/5 and in the running paragraph, the surviving <1500 g twin's birth weight is given as 1440 g (25 June) reaching 3080 g by 26 October, but the table lists Obs. 4 (Thérèse) at 1460 g entry / 1440 g minimum and Obs. 5 (Valérie) at 1730 g — so the "1440 g at birth" in the prose corresponds to the twin recorded as Obs. 4.

[1] Dr. Ciaudo. La Maternité Lion de Nice pour enfants nés avant terme ou débiles. Nice, imp. V. Eug. Gauthier et Cie, 1895, 53 p.

Synoptic table of observations

#	Name	DOB	Gestation	Entry wt.	Entry temp.	Min. wt.	Loss dur.	Return to birth wt.	Stay	Discharge wt.	Mean daily gain (g)	Later weight	Notes
1	P. Marguerite	4 Aug	26–27 wk	1010 g	35.6°	840 g	—	—	—	—	—	—	Died on 4th day
2	Y. John	26 Jul	28 wk	1320 g	35.4°	1240 g	12 d	20 d	11 wk	2050 g	13.3	2500 g at 3¼ mo	Thrush, 5th–7th day
3	S. Jeanne	28 May	29 wk	1330 g	35.4°	1140 g	8 d	17 d	11½ wk	2460 g	16.3	3870 g at 5¼ mo	Incubator at home
4	C. Thérèse	25 Jun	35 wk	1460 g	35.6°	1440 g	15 d	17 d	11½ wk	2540 g	17.0	3080 g at 4 mo	Twins. Febrile jaundice; mild diarrhea 5–15 Jul
5	C. Valérie	25 Jun	35 wk	1730 g	35.3°	1690 g	3 d	18 d	11½ wk	2300 g	9.4	2620 g at 4 mo	Febrile jaundice; diarrhea during Aug
6	Z. Edmond	6 Jul	30–32 wk	1590 g	35.2°	1520 g	9 d	14 d	12 wk	2640 g	15.1	—	Navel suppuration to 10 Jul; jaundice 5–12 Jul; double inguinal hernia
7	K. Hedwige	20 Aug	30½ wk	1700 g	36.5°	1490 g	11 d	33 d	8½ wk	2210 g	15.0	2600 g at 2¼ mo	Ophthalmia cured 5th day
8	D. Louis	7 Jul	30 wk	1740 g	<33°	1335 g	—	—	—	—	—	—	Died 14th day; normal temp from 2nd day
9	M. Marguerite	10 Sep	35½ wk	1780 g	35.2°	—	—	—	—	—	—	—	Died 7th day
10	R. Alice	21 Sep	32 wk	1790 g	<34°	1700 g	16 d	24 d	4 wk	1930 g	19.2	—	37.2° day after entry
11	L. Gabriel	5 May	36 wk	1935 g	—	1935 g	8 d	19 d	5 wk	2590 g	19.3	2670 g at 2¼ mo	Mother died phthisic 15 d post-partum; birth wt. 2430 g; incubator from day 8; thrush; diaper rash; died at 3 mo
12	A. Edmond	11 Aug	33 wk	1970 g	34.5°	1450 g	—	—	—	—	—	—	Foot wound at entry; jaundice; bronchopneumonia; died 26th day
13	F. Albert	7 Jun	?	1980 g	34.1°	1710 g	14 d	28 d	7 wk	2400 g	20.9	—	—
14	J. Hélène	21 Jul	33 wk	2000 g	35.4°	—	—	—	—	—	—	—	Sudden death day after birth
15	C. Emma	9 Sep	34 wk	2020 g	35.0°	—	—	—	—	—	—	—	Died day after birth
16	F. Juliette	3 Jun	34 wk	2070 g	34.6°	1700 g	13 d	34 d	8 wk	2610 g	21.7	—	—
17	G. William	6 Jun	37 wk	1940 g	35.8°	1910 g	4 d	16 d	4 wk	2785 g	28.3	—	Birth wt. 2080 g; brought to incubator on 6th day
18	M. Marcel	12 Sep	36 wk	2420 g	36.0°	2330 g	1 d	16 d	5 wk	2950 g	18.8	3590 g at 1½ mo	—
19	M. Auguste	14 May	36 wk	2370 g	35.0°	2370 g	5 d	9 d	2½ wk	2800 g	22.6	—	Birth wt. 2540 g; brought to incubator on 5th day
20	M. Louis	3 Jun	36 wk	2780 g	36.2°	2595 g	10 d	18 d	3 wk	3040 g	37.5	3230 g at 1 mo	Jaundice 2nd to 8th day